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CONTENTS

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THE GENESIS OF THE ATTENTION IN THE EDUCATIVE PROCESS[1]

EDUCATION is suffering from a sort of dual personality. Its psychology and practise move along in more or less parallel lines without the one greatly interfering with the other. Evidence that interest, when it exists, must always follow attention to the idea or group of ideas which called it out, does not deter the enthusiastic teacher from giving this interest an external source instead of ascribing it to the mind.

Attention results from the mind's acquiescence in the focal presence of a particular idea or group of ideas. This is true whether the attention be of the so-called passive or active variety, since the only difference between the two lies in the complexity of the latter. In "voluntary" attention, more than one attraction is offered, and, each presenting inducements, the mind receives the one with more or less consciousness of what it has lost in giving up the other. This consciousness of deprivation, together with certain muscular sensations, probably makes up the feeling of effort which has caused this form of attention to be popularly thought active. Attention means a certain arrangement of the content of consciousness, which gives clearness to one idea or group of ideas, and produces comparative, though not equal, obscurity of the others. Change of attention requires a redistribution of the content, and this is accompanied by a re-

[1] Read before the joint meeting of the American Psychological Association and Section L—Education; American Association for the Advancement of Science, Minneapolis, December, 1910.

arrangement of clearness. The change may be partial or complete, depending upon the operating causes and upon the condition of the mind.

The educational problem is to secure attention for certain ideas which make for growth, and the difficulty in solving this problem is that these ideas, intended, as they are, to prepare children for the future rather than the present, are likely to represent types of experience beyond the children's stage of development. One can not avoid a certain sympathy with the eleven-year old girl who refused to try to find how many times a bucket must be filled to empty a circular well, the height and bottom radius of which were given, together with the height and radii of the bucket, on the ground that no one but a fool would try to empty a well in that way. To give attention to ideas whose value is a future asset requires rejection of those of present significance, and the mind refuses to make this sacrifice unless convinced of a more deserving claim. This is the reason for our unwillingness to listen to a friend when we are hurrying to a train.

If active attention differs from passive in the number of applicants for the limited accommodations in the focus of consciousness, the very practical question arises concerning the part the educator may play in this contest. It looks as though he enters the competition so heavily handicapped as hardly to be able to show his wares.

The feelings have been thought to be the strategic base of operations from which a successful flanking movement could be started. The innumerable and disorderly mental processes of youngsters could then, it was believed, be driven into a narrower line of march, and finally, as they became more restricted, be compelled, in sheer self-defense, to give heed to the interesting ideas which the skillful teachers always put at the head of their attacking column.

Unfortunately, however, for this theory, a little observation shows how unreliable are the feelings after we have marshalled our forces for the attack. A college student recently told the writer that, after an eloquent exposition by his professor of English history of the period of George III., it was mentioned, as an instance of that monarch's abstemiousness, that he always had boiled mutton and turnips for dinner. Now, if there are any articles of diet which this student abhors, it is boiled mutton and turnips. Consequently, all the deserving ideas related to the period of George III. were forced to yield, for the time, to the domination of turnips and mutton, and when, the following year, George III. was reached in American history, all other ideas were driven from the consciousness of this young man while he breathlessly waited again for mutton and turnips. Evidently the feelings are an unsafe educational guide, if hateful objects and ideas may be as attractive as those which are pleasant.

Again, rewards and penalties have seemed to some to be the effective means of winning the attention. The first fails on account of uncertainties regarding the sort of knowledge which will secure the reward, and the second is unproductive because the teacher and the implied punishment are too prominent in the consciousness of the learner for efficient concentration. Further, both of these incentives divide the attention. The prerequisite of a productive state of consciousness is that all diverting ideas and objects, including the teacher himself, pass out of consciousness and leave the field free for the competitive interaction of the mental processes created by the work in hand. Ideas may be forced upon children while the native impulses are restrained by penalties, much as one may be compelled to eat what does not suit his taste, but the mind refuses to

react just as gastric juice is stingy of its flow when food is unattractive. Whether, in this apparently unequal contest with native impulses, educative ideas may be aided in other ways than by relieving the mind of what may be called the school consciousness, and by giving it freedom of action, remains to be discussed.

The growing point in elementary and secondary education is the special schools for delinquents, and reformative institutions. The reason for this is that the boys in these schools are so much the primitive man that the traditional plan of education breaks down completely when applied to them. On this account, the experimental method, which until recently was regarded as so heretical as to justify the excommunication of its advocates from the communion of righteous pedagogues, was forced upon those in charge. The result is that delinquents have the best schools. And they secured them by refusing to submit to the traditional method.

Not the least curious thing about these disciplinary schools is that they require less discipline than the ordinary school. Of course, a dose of disciplinary medicine is sometimes necessary at the beginning. It has much the same value as that which David Harum attributed to fleas on a dog. Too sudden a break with one's past is likely to prove disastrous.

It should be remembered that disciplinary schools and reformative institutions deal with youngsters who can not be controlled in the ordinary school. To be able, under these circumstances, to produce in the majority of the boys a condition of consciousness attentive to study, and to develop a mental attitude responsive to social incentives is certainly remarkable. Instances of unusual influence have been often noticed, but the success is generally explained by the vague term personality. The method of these teachers, however, is strikingly similar. They secure attention to their ideas by identifying them with the racial instincts characteristic of boys.

Efficiency in education reduces itself largely to the attitude of the learner toward instruction. In the more mature, many derived interests cluster around desire for success, but in children these control elements only occasionally exist. With them, the problem is to capture a purposeless, wayward attention often enough, and to hold it long enough, to impress the mind with the significance of a few derived interests which may serve as a new base of operations from which to push on to further development. One's attitude toward knowledge depends upon the mental content. The ideas and activities of children are the stuff out of which their thoughts are made. In early life, this material is social, and it is social because it is racial.

The force of this social instinct is seen in the number of clubs formed by boys without the assistance of adults. Sheldon found[2] that seventy-two societies were represented among one hundred and seventeen boys of eight and nine years of age, and six hundred and twenty-five societies among seven hundred and forty-eight boys from ten to thirteen, inclusive. This investigation included three New England cities and two on the Pacific coast. Clearly, the social instinct is a tremendous educational force.

Johnson says[3] that the children in his vacation school preferred "to submit to a flogging as evidence that they sincerely intended to resist temptation" to disobey, "rather than to stay away from school." "Nearly every species of butterfly to be found in Andover, Mass., during the sea-

[2] *American Journal of Psychology*, Vol. 9, p. 425.

[3] *Pedagogical Seminary*, Vol. 6, p. 516.

son was captured" by his children. Many kinds of caterpillars were watched as they developed into chrysalides in the cages, and nearly all the different kinds of fishes to be found in the streams and ponds were caught and studied. Much of this work was done outside of school hours. What enthusiasm is this for securing attention to knowledge in almost every subject of the curriculum!

A child has many possibilities, only one of which reveals itself under a given set of conditions. The self is not one and unchangeable, though it acts as a unit in a particular situation. The group offers a diversity of ideas, and the one selected is less individually selfish in proportion as it partakes of the group spirit. Children are intolerant of personal self seekers, and the group sentiment dominates partly because of its larger, more universal worth. It meets the needs of individuals through its adaptiveness to the wants of the entire group. What the group decides is for its good the individual accepts. In this way the group sentiment directs and rules the attention of those who contribute to its spirit.

Children are rarely inattentive to work which they regard as their own. The group sentiment is always active in determining what ideas shall occupy the focus of consciousness. To remain members of the group, boys must attend to business. Making children feel that the work is theirs and not the teacher's means, then, securing the attention. But this can only be done by utilizing the racial instincts in the educative process. This, the schools have failed to do and, as a result, teachers are continually working against the resistance of the group consciousness. The school is divided into two camps, the one, the teacher, trying to win attention by creating factitious interests, and the other, the children, momentarily attracted by these devices but always watchful of a chance to assert their social selves.

The productive efficiency of the energy released by group sentiment is seen in the results accomplished under the name of play. It is not the nature of the activity that distinguishes work from play, so much as the mental attitude assumed toward the occupation. The same subjects of study are tedious under the ordinary class method and interesting when made the order of business in a club of the members of the class, of which the teacher is an integral but inconspicuous part. The club idea appeals to the racial instincts of love of glory—showing off—and personal competition, both of which are elements in the group sentiment. There is no lack of attention here.

The utilization of the racial instincts in securing attention to educative ideas has been resisted by school-men largely because of the educational dogma of effort. Effort has been greatly overworked of late. Attention does its best work when the feeling of effort is wanting. Effort indicates resistance or strain, and accompanies inefficient attention. As we become proficient in our work, it decreases and, finally, disappears completely. The reverence for effort has arisen in the misapprehension of the relation of feelings to attention, and in the belief that strain has some occult pedagogical value. That which is pleasant is not for that reason easy, nor is the difficult necessarily unpleasant. It is intensity of thought which counts in mental development. The feeling of effort adds no value to the educative process. Consciousness of strain indicates imperfect attention with undue prominence of muscular sensations, or friction. The friction may be caused by the novelty of the ideas, by bodily discomfort, or by temporary mental incon-

gruity, as when one has heard bad news. If the incongruity is permanent, because of lack of ability to give the ideas an orderly arrangement, their educative value is at least doubtful.

Attention is determined by past and present states of consciousness. In childhood, these states of consciousness are largely racial and social, and continued attention can be secured only by creating educational situations in which the school consciousness loses its identity in the racial and social consciousness.

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THE CHEMISTS' CLUB[1]

I HAD the honor, I believe, of presiding over the first meeting of the New York Section of the American Chemical Society held in the Assembly Hall of what subsequently became the quarters of the Chemists' Club, and I feel honored in being invited to address the last meeting held in those quarters. At that first meeting expression was given to hopes which to some, at that time, seemed extravagant, but which have now been splendidly realized.

It will not be out of place nor without interest, I am sure, to briefly recall some of the facts and influences which led to the ultimate organization of the Chemists' Club—a club which has, for more than a decade, had such a potent influence in centralizing the interests of the chemists of New York and the vicinity, and has furnished a home for these chemists and their several societies and associations.

At the meeting of the American Association for the Advancement of Science, held in Boston in 1898, the question of the disposal of the books and other material constituting the library of the association was discussed. It was decided to consign this material to the University of Cincinnati. In the meeting of the council of the American Chemical Society held at about the same time and in the same place, inquiry was made concerning the location and condition of the books and material constituting the library of the American Chemical Society. After the closing of the old university building on Washington Square, which had housed the library for several years, all of the material had been packed in boxes and placed in fire-proof storage, where it was entirely inaccessible for consultation and use. On my return trip to New York after the close of that meeting I was accompanied by Dr. Charles F. McKenna. Our conversation naturally turned upon the material constituting the library of the society, regarding the disposition of which no decision has been made. This library was known to contain much valuable chemical material not otherwise available in this country, and it was evident that its removal from the city would be a misfortune to the local chemists. In the course of our conversation, Dr. McKenna suggested that, with the retention of the library in this city as an incentive, it should be possible to arouse sufficient interest in the matter of organizing a chemists' club to make such an enterprise an established fact.

In the year or two preceding, Professor A. A. Breneman had endeavored to arouse interest in such a project, but with no special end in view, such as the retention of the library, the effort proved ineffectual. The results were, nevertheless, influential in promoting the ultimate organization of the club as we know it.

Soon after our return from Boston, Dr. McKenna called me by telephone to tell me he believed that the inexpensive but

[1] Address before the New York Section of the American Chemical Society on March 10.

commodious quarters (which we had agreed were essential to the project) were available in the recently vacated rooms of the Mendelssohn Club at 108 West 55th Street. Upon his invitation I joined him in an inspection of the premises. We were so favorably impressed that we concluded it would be eminently advisable to call a meeting of the members of the New York Section of the Chemical Society and of other chemists in the city, for informal discussion of the desirability and practicability of establishing and maintaining such an organization of chemists as should lease and occupy the quarters referred to, the assembly hall of which was even then comfortably filled by the chemists attending the meeting. The expression of opinion was almost unanimous that the project was not only desirable, but practicable as well, and that the quarters were admirably suited to the purposes in question. The reasons were ample—there was a library to be housed and put in shape for practical use, there was need of a place for meetings of the various chemical organizations, and there was a distinct demand for a place to serve as the chemists' headquarters in both a professional and a social way. I was authorized to appoint a committee to report upon ways and means for promptly carrying out this project. I lost no time in appointing as chairman of this committee, Dr. Charles F. Chandler, who, more than any other, held the respect and esteem of the chemists of New York, and about whom these chemists would enthusiastically rally. Dr. Chandler was authorized to complete the committee, the final work of which is well known. And so the project suggested by Dr. McKenna was launched.

That the hopes we all had at that time regarding the enterprise should be so fully realized in such a comparatively short time, and that their realization should have had so important and profitable an influence upon the interests of the chemists and the chemical organizations of New York, few of us dared confidently to expect.

The Chemists' Club was finally organized in November of 1898, the constitution declaring its objects to be "the promotion of good fellowship among its members and the advancement of the science and the applications of chemistry." The quarters already described were leased and furnished and space was assigned for the library. The task of transferring the material, unpacking, classifying and shelving it was begun by Professor A. A. Breneman and finally carried out by Dr. E. G. Love, to whom is really due the credit of bringing the library to its present efficient condition. The labor involved in this work was great and was willingly rendered with no compensation other than that which must come from having so effectively promoted the interests of the chemists and the chemical organizations of both the city and the country.

The first scientific gathering held in the assembly hall of the club was the meeting of the New York Section of the American Chemical Society.

The Chemists' Club is now on the eve of another epoch in its history. While we shall experience some regret in leaving the old quarters which have served us so comfortably for such a long period, it will be with pleasant memories only, and justifiable pride that we remove to the new building of the Chemists' Club, which is a splendid monument to the foresight, judgment and generosity of the club's former president, Dr. Morris Loeb, and the efficiency of the directors of the building company, who have been charged with the financing of the enterprise and the erection of the structure. The club and the affiliated

societies will now have greater facilities than ever before.

Those of us who were associated with the club in its infancy are watching with most intense interest its evolution into maturity. We are expecting great things of the Chemists' Club and I am sure we shall not be disappointed. With its past as a background, with its organization and equipment as a foundation, and with the opportunities before it as inspiration, the auguries for the future are bright indeed.

WM. MCMURTRIE

THE WORK OF THE "MICHAEL SARS" IN THE NORTH ATLANTIC IN 1910[1]

DR. HJORT'S preliminary account of the *Michael Sars* expedition is so important, both to the oceanographer and to the marine biologist, that a résumé is justified, although the final report is yet to come.

The expedition, under the direction of Sir John Murray and Dr. Hjort, left Plymouth in April, ran thence to the west of Ireland, across the Bay of Biscay to Gibraltar, and so to the Canaries. From here the course was a "large section of the Atlantic," visiting the Azores, the Sargasso Sea and eventually Newfoundland, whence a section was undertaken to Ireland. Finally work was carried on south and north of the Wyville Thompson ridge.

Especially instructive are the hydrographic sections of the northwestern Atlantic, the observations on currents in the Straits of Gibraltar and off the Azores, the notes on the smaller plankton, and the data acquired on the bathymetric distribution of the fishes and crustaceans of the intermediate waters.

The sections from the Sargasso Sea to Newfoundland and from Newfoundland to Ireland show that the surface layer of warm water with high salinity (over 35 per m.) is very much thicker on the eastern than on the western side of the Atlantic. Off the Newfoundland bank the uniform "bottom water" with a temperature of about 2.5° C., and salinity of about 34.9 per m., rises close to the surface.

If we compare these observations with data obtained by the *Challenger* and by the *Blake*, with the scattered records made by the *Albatross*, and with the few temperatures I have myself taken in the intermediate waters of the Gulf Stream, we find that they are all in accord on this main point. In the northern portion of the Gulf Stream its warm waters are extremely shallow along its inner edge.

The two sections in question illustrate what to the oceanographer is a most important discovery; viz., an upwelling of the cold bottom water partially dividing the warm surface layer into two bands. Thus on the line Newfoundland-Ireland, the temperature at station 83 at about 275 fathoms is the same as it is at 350 fathoms at stations 81 and 85, east and west of it; *i. e.*, 8° C. (46.4° F.). And the salinity curve shows a similar rise. On the line Sargasso Sea-Newfoundland, the "sunderance" of the warm surface water is much more extreme. Thus at station 66 water of 8° C. (46.4° F.) was found at only about 150 fathoms, and of only 14° C. (57.2° F.) and salinity of 35 per m. within less than 50 fathoms of the surface.

On looking over the *Challenger* temperatures on the line Halifax-Bermuda, taking the actual observations, and not those computed from the "average curve" I was struck by the fact that at station 53, at roughly the same relative position, the temperature at 100 and at 300 fathoms was about the same as it was about 50 fathoms deeper at stations 52 and 54, on either side of it. The variation of only about 1° F. is a very slight one, but taken in conjunction with the observations of the *Michael Sars*, and with the fact that the upward swing of the isotherms lies in the direct continuation of the cold ridge shown by Dr. Hjort in his chart of the conditions at 200 fathoms, it certainly suggests the *possibility* that it was an actual phenomenon in 1873 as it was in 1910, not a faulty observation.

Dr. Hjort suggests that if this remarkable

[1] Johan Hjort, "The 'Michael Sars' North Atlantic Deep-sea Expedition, 1910," *Geographical Journal*, Vol. 37, 1911, pp. 349–377, 500–523.

phenomenon proves to be a regular feature, which is, of course, still doubtful, it indicates the existence of a counter current running to the southwest. This may be the correct explanation. But, as he cautions us, it requires further investigation, especially to test its constancy. Vertical circulation, as well as horizontal, may be playing its part here. Current measurements at different depths could not fail to yield valuable results.

As a whole the intermediate waters proved to be considerably colder in 1910 than they were in 1873, differences as great as 5° C. being observed, though the surface and the deeper layers agreed fairly well wherever the paths of the two expeditions approached each other. Such periodic fluctuations are known for the Norwegian Sea, but they offer a virgin and most interesting field in the northwestern Atlantic.

The shallowness of the warm surface layer in the western part of the Atlantic leads Dr. Hjort to conclude that its cold bottom waters come to it from the northwest; *i. e.*, from Baffins Bay. In this connection an examination of the Labrador current would be of great value; as yet we know almost nothing about the physical properties of the intermediate waters north of, and at its meeting with, the Gulf Stream, though its importance as a surface phenomenon has long been recognized.

The character of this Arctic flow, and its relationships to the Gulf Stream and to the comparatively warm water along the western shores of Greenland offer an attractive and important field for oceanographic research, one lying naturally at the doors of American oceanographers. In such a study, current measurements at different depths on and near the Newfoundland banks would be of prime importance. And that such can be made in considerable depths has been proved by the *Michael Sars*.

A series of 70 current measurements were made at eight different depths in the Straits of Gibraltar, from the ship itself, in 200 fathoms. These show very clearly how the inflow into the Mediterranean is limited to the upper 75 fathoms (about) while at its height, with a velocity of about 1 m. per second. On the other hand, when the outflow was at its height the surface current was slight, whereas the current into the Atlantic reached the velocity of 2 m. per second.

A second series of measurements off the Azores show that there may be considerable tidal currents, even as deep as 800 meters.

The biological results are quite as important as the oceanographic. With regard to the finer plankton, the most important results are that there is much more in coastal than in oceanic waters, and that in oceanic waters the maximum of vegetable plankton was at about 50 meters, less at the surface.

By the time 100 meters was reached there was only about one tenth as much as 50. Dr. Hjort tells us that the different groups occupy different bathymetric zones, the Peridiniæ nearest the surface, next the coccoliths, and deeper the diatoms. As to quantity, the living plant cells are estimated at 3,000 to 12,000 per liter of sea water.

The collection of the larger plankton, fishes, crustaceans, etc., was very rich; and the depth data were valuable, thanks to the method of using the serial nets developed by Dr. Hjort. For the details of the apparatus I must refer the reader to Dr. Hjort's account; but, essentially, it consisted in using a series of ten different horizontal nets simultaneously at each station. It seems to me, as it did to Dr. Hjort, that "provided that the catches were large . . . the mere numbers would demonstrate *sufficiently convincingly* at what depth the captures had been made."

The data on the vertical occurrence of fishes and crustaceans have proved to be most valuable—they throw an entirely new light on the whole subject. In the first place they show very clearly that the intermediate fishes and crustaceans are not homogeneous so far as their bathymetric range is concerned, but that species closely allied systematically may differ in their distribution. Thus the fish *Cyclothone microdon* and the prawn, *Acanthephyra multispina,* belong to a deeper zone than their relatives *C. signata* and *A. pur-*

purea. Adults of the former group were most abundant below 500 meters, larvæ (*Acanthephyra*) alone were taken in the upper layers of water. The oldest specimens were from the deepest layers, down 1,500 m., and the depth zones for corresponding sizes were deeper on the southern than on the northern lines. The second group, on the other hand, reaches its maximum higher up, at about 500 m., but here too the older specimens were found deeper on the southern than on the northern lines.

As a rule black and red forms prevail among the larger inhabitants of the intermediate waters. This rule is not absolute, since two species of black fishes were found within 150 m. of the surface. But these two, like *Cyclothone signata,* have highly developed light organs. And it is even more significant that all the captures of them from depths less than 500 m. were made at night; furthermore, as Dr. Hjort points out, there are previous records of black fishes, *e. g., Idiacanthus* and *Astronesthes,* being taken close to the surface at night.

Experiments on the penetration of light, carried on by means of an improved photometer, devised by Dr. Helland-Hansen, showed that there is a close correlation between the lower limits of light of different colors and the vertical occurrence of the black fishes and red prawns. Off the Azores the blue and violet rays were still detected at 500 meters, though the red had been absorbed entirely; at 1,000 meters the ultra-violet rays were still perceptible, but at 1,700 no trace of light was found. That is to say, prawns and black fishes, in the day time, are confined to a zone below the penetration of red light: it is only at night that the fish with large light organs are found higher up in the water. While their upper limit is higher in high than in low latitudes, the same must, on physical grounds, be true of the penetration of light. Furthermore, the theoretical calculations of the penetration of light at different latitudes shows that it agrees very well with the upper limits of the red prawns from the lines of the *Michael Sars* and from the Norwegian Sea.

At a higher level than that occupied by the red and black forms, where sunlight is appreciable, *i. e.,* with a lower limit, in temperate latitudes, of say 500 m.; and a maximum at about 300 m. is a totally distinct fish fauna, characterized by lateral compression, larger and often telescopic eyes, large light organs and silvery sides, examples being afforded by *Argyropelecus* and by various Sternoptychidæ and Stomiatidæ.

These observations rest on such a mass of data that they seem altogether worthy of acceptance. They form one of the most important of recent additions to oceanic biology. They are of special interest to the reviewer because of his studies on the medusæ of the intermediate waters collected by the *Albatross.* Among the latter, as among the fishes, there are two distinct color groups, one slightly pigmented, if at all, but iridescent; the other densely pigmented with red or brown. Both have numerous representatives. Our knowledge of their vertical occurrence is still scanty; but we know that they do not normally come to the surface, except in very high latitudes. On the other hand, they are by no means confined to abyssal depths. The important question in connection with Dr. Hjort's article is whether the two color-groups of medusæ correspond to the two color-groups of fishes in their bathymetric occurrence. To this an answer can not be given definitely as yet. I have already suggested[2] that it is light which demarks their upper limit as a whole. And it is at least suggestive that at one station in the eastern tropical Pacific the *Albatross* took 3 genera of "red" medusæ in a Tanner closing net at 400 fathoms (one of them being also taken in an open net from 300 fathoms), but none of the "iridescent" group, while at the same station two "iridescent" genera were taken in the closing net from 300 fathoms, and two others in the open net from the same depth. These records suggest that at this station, at least, the red medusæ occurred as a whole below the iridescent ones, but that the two overlapped at, say, 300–250 fathoms. One may

[2] *Mem. Mus. Comp. Zool.,* Vol. 37.

hope for much more extensive, perhaps conclusive, evidence along this line when the medusæ of the *Michael Sars* are worked up.

Dr. Hjort believes that the zone marking the upper limit of the red and black forms is particularly rich quantitatively, a view to which I subscribe, having already argued that it is probably true for the medusæ. If his observation that there is a sudden rise in density as we go down through the intermediate layers, where sinking organic débris would tend to accumulate, be extended to the oceans as a whole, it must be one of the most important factors in the ecology of the mesoplankton. In this connection, of course, it is neither salinity nor specific gravity reduced to a standard temperature which is required, but the density of the water at the temperature *in situ*.

Among the mass of surface forms Dr. Hjort mentions especially the transparent fish larvæ, 90 per cent. of which were secured within 150 meters of the surface; of special interest being the occurrence there of pale larvæ of the black *Gonostoma elongatum*, and of deep-sea macrurids. On the other hand, the larvæ of other deep-water forms were taken at about the same bathymetric levels as the adults. In these cases the larvæ are not transparent, but show the pigmentation of the adult. Their color and vertical occurrence are correlated from the earliest stages.

The notes on horizontal distribution are valuable. Thus the captures have extended the ranges of several "rare" deep-water forms to practically the whole north Atlantic; others, however, especially several species of *Cyclothone*, seem to be limited to southern regions. The three centers of abundance for transparent young fish were south of the Azores, west of the Canaries, and off the Newfoundland bank. Among them many interesting stalked-eyed forms were taken, and large series of Leptocephali of at least 20 species.[3]

Finally we have an account of the trawlings. As yet the material is only partially worked up; and as the results may be expected to be of great general interest, it is best to delay our review of them till the final account appears, merely pointing out here the uniformity of the fish fauna at 500 fathoms, from the Wyville Thomson ridge to the Canaries, as opposed to its great diversity in shallow water. The work also supported earlier conclusions that there are some species of fishes and invertebrates south of the ridge separating the Atlantic from the Norwegian Sea, not found north of it, and *vice versa*.

In conclusion, every student of oceanic phenomena owes a debt of gratitude to Dr. Hjort and to Sir John Murray for the well-planned and successfully executed operations of the expedition. The methods employed deserve to be, and will be generally, adopted. To those of us who have participated in deep-sea investigation, it is a revelation that so much and such good work could be done from a vessel of only 226 tons, and that financial obstacle need no longer loom so large as it has in the past.

As Dr. Hjort points out, the Atlantic is still a "fruitful field for future investigation into the pelagic life of the ocean"; and he has himself opened many attractive vistas to other students.

Henry B. Bigelow

[3] Some of these, the larvæ of the European eel, have been described in an earlier paper (*Nature*, November 24, 1910).

SCIENTIFIC NOTES AND NEWS

Dr. Abraham Jacobi, emeritus professor in Columbia University, was elected president of the American Medical Association, at the meeting held last week at Los Angeles.

Professor William G. Raymond, head of the department of civil engineering and dean of the College of Applied Science at the State University of Iowa, has been elected president of the Society for the Promotion of Engineering Education.

Harvard University has conferred the doctorate of letters on Dr. Josiah Royce, professor of philosophy, and the degree of master of arts on Dr. William B. Coley, professor of clinical surgery in Cornell Medical College,

on Professor Henry S. Graves, chief forester of the U. S. Forest Service, and on Major W. V. Judson, of the corps of engineers of the U. S. Army.

DARTMOUTH COLLEGE has conferred its doctorate of science on Professor Edwin B. Frost, of the class of '86, director of the Yerkes Observatory and formerly professor of astronomy at Dartmouth College.

AMHERST COLLEGE has conferred its doctorate of laws on Dr. Walter Wyman, of the class of '70, surgeon general of the U. S. Public Health and Marine Hospital Service.

THE degree of doctor of engineering has been conferred by the University of Illinois upon Mr. Ralph Modjeski, bridge engineer.

DR. R. A. MILLIKAN, professor of physics in the University of Chicago, has been given a doctorate of science by Oberlin College.

THE Jefferson Medical College has conferred the degree of Sc.D. on Dr. Victor G. Heiser, class of 1896, director of health in the Philippine Islands.

THE Royal Society of Arts has awarded its Albert medal for the current year to the Hon. Charles A. Parsons, F.R.S., for his experimental researches on steam engines of the turbine type.

DR. L. HEKTOEN, of the Memorial Institute for Infectious Diseases, Chicago, has been elected foreign member of the Norwegian Medical Society of Copenhagen.

DR. P. WALDEN, professor of chemistry at Riga, has been elected a member of the St. Petersburg Academy of Sciences, with the privilege of retaining for the present his chair in the Polytechnic School at Riga.

DR. SVEN HEDIN, the Swedish explorer, has been elected a member of the Paris Academy of Sciences.

PROFESSOR V. ESMARCH, of Göttingen, has resigned the direction of the hygienic institute on account of illness and has been relieved from giving lectures.

DR. ALBERT EULENBURG, professor of diseases of the nervous system at Berlin, celebrated the semi-centennial of his doctorate on May 31.

THE eighth volume of the "Contributions from the Jefferson Physical Laboratory" is dedicated to Professor John Trowbridge, the director emeritus. The volume contains twenty-six papers, and has the following dedication to Professor Trowbridge:

TO JOHN TROWBRIDGE

who projected a great physical laboratory for Harvard University and found the means to build and equip it, who by his foresight, invention and care has kept this laboratory among the foremost in opportunities for scientific achievement, and by his magnanimity has made it a place proverbial for good feeling, this volume is gratefully and affectionately dedicated by those who have profited by his labors and enjoyed his friendship.

UNDER authority recently given by congress, Surgeon General Wyman has designated the U. S. Marine Hospital at Wilmington, N. C., as a special research hospital for zooparasitic diseases. Professor C. W. Stiles, of the Hygienic Laboratory, has been ordered to divide his time between Washington, D. C., and Wilmington. He will have charge of the biological side of the investigations while Surgeon Charles H. Gardner will have charge of the more strictly medical side of the work. The new law permits the hospital to take in free patients, not to exceed ten in number at any one time, for study of infectious and contagious diseases. Dr. Stiles takes three assistants to Wilmington. A camp of six tents has been erected in the hospital grounds for quarters.

DR. OSKAR HECKER, observer in the Geodetic Institute at Potsdam, has been appointed director of the bureau of the International Seismological Association at Strassburg.

DR. LOUIS SIMONIN, assistant director of the Nice Observatory, has been appointed astronomer in the Paris Observatory.

DR. OTTO KLOTZ, of the Dominion Observatory, will attend the Manchester meeting, July 18–22, of the International Seismological Association as delegate for Canada.

MR. SIDNEY L. GALPIN, of the department of geology at Cornell University, is director of a party of Oberlin students doing summer work in geology in western Virginia.

DR. FRANK M. SURFACE, of the Kentucky Experiment Station, sailed for Europe on June 30 to spend six months in study and travel.

AN expedition to Newfoundland in the interest of the Gray Herbarium, Harvard University, under the direction of Professor Fernald, left Boston on June 30. Professor Fernald is accompanied by Professor Karl M. Wiegand, of Wellesley College, and Messrs. Edwin B. Bartram and Bayard Long, of the Academy of Sciences of Philadelphia, with Mr. Henry T. Darlington, a graduate student, as general assistant. Headquarters will be at Grand Falls on the Exploits River, and the explorations will be chiefly on the northeast coast of the island, thus supplementing the former explorations of Professors Fernald and Wiegand on the northwest coast.

A BRONZE statue of Dr. Traill Green has been erected at Easton, Pennsylvania, where he was a practising physician until his death in 1897 at the age of eighty-four years. He had also been professor of chemistry at Lafayette College and dean of the scientific department.

FUNDS are being collected for the purpose of erecting a monument to honor the memory of the late Professor Cesare Lombroso, at his native place, Verona, Italy.

PROFESSOR JULIAN WILLIAM BAIRD, dean of the Massachusetts College of Pharmacy and professor of chemistry, died on June 26, in his fifty-third year.

SIR RUPERT BOYCE, Holt professor of pathology in the University of Liverpool, known for his important contributions to our knowledge of nervous and tropical diseases, died on June 16, aged forty-nine years.

DR. K. POLSTORFF, associate professor of pharmacological chemistry at Göttingen, has died at the age of sixty-six years.

DR. CHARLES G. WELD has bequeathed to the Boston Museum of Fine Arts his collection of Japanese paintings and lacquer work which has been in the custody of the museum as a loan collection and to the Peabody Museum at Salem all the property now in the custody of that institution, including the collection from the South Seas, and the sum of $25,000.

THE death is announced of Dr. Heinrich Stilling, professor of pathological anatomy at Lausanne.

M. PEDRO CHRISTOFFERSEN, a Norwegian, of Buenos Aires, has offered to pay the expenses for the provisions and other outfit of the *Fram*, Captain Amundsen's ship, both during the ship's stay at Buenos Aires and during the oceanographic expedition to the Antarctic seas now being conducted by Captain Amundsen. He will also bear the expenses of outfit when the *Fram* returns in August next in order to fetch Captain Amundsen and his companions in the coming spring.

MR. GEORGE ROBERT WHITE, of Boston, has subscribed the sum necessary to rebuild and considerably enlarge the laboratories connected with the Gray Herbarium. The new structure will be a two-storied thoroughly fireproof wing, sixty feet long and thirty broad, extending from the central portion of the building toward the conservatories. The lower story will contain two laboratories for work in systematic and geographic botany, while a portion of the upper will be equipped for the herbarium of the New England Botanical Club. Mr. White's gift includes $21,500 for construction and $10,000 for equipment. The cases and, so far as possible, the other furnishings will be of steel. Through an anonymous gift of $25,000, announced some weeks ago, the herbarium will also be provided with a library wing, to extend from the main building toward Garden Street and to cover a portion of the site formerly occupied by the Gray residence, recently removed. Plans for these two extensions, prepared by Mr. W. L. Mowll, have been approved by the corporation and construction will begin as soon as practicable. Mr. Casimir de Candolle, of Geneva, has given to the Gray Herbarium a cast of a

bust of his father, Alphonse de Candolle, in remembrance of the constant friendship between his father and Asa Gray. The bust is by Hugues Bovy.

THE Arnold Arboretum of Harvard University announces the publication of the first volume of "The Bradley Bibliography," a guide to the literature of woody plants, including books, and articles in the proceedings of learned societies, and in scientific and popular journals, published in all languages to the end of the nineteenth century, prepared at the Arnold Arboretum by Mr. Alfred Rehder, under the direction of Professor Charles Sprague Sargent. The work will extend to between 4,000 and 5,000 quarto two-column pages and will consist of five volumes, as follows: I., Dendrology—General; II., Dendrology—Taxonomic Arrangement; III., Economic Products and Uses of Woody Plants—Arboriculture; IV., Forestry; V., Index of Authors and Titles.

THE *Geographical Magazine* gives some details in regard to the piercing of the Lötschberg in the Bernese Alps, completed on March 31 by the junction of the galleries driven from the north and south which marks an important step towards improved communications across the Alpine barrier of central Europe. The project forms the natural complement of the piercing of the Simplon, in supplying a further link in the future trunk line of communication from northwestern to southern Europe, besides giving to Berne (in the interests of which city the scheme was first set on foot) its needed access to the more westerly of the two great international routes across Switzerland, between which it has hitherto lain isolated. The northern entrance to the tunnel, at Kandersteg, is reached by a prolongation of the line up the Kander Valley from Spiez on the Lake of Thun, and the southern, at Göppenstein, is linked with the Simplon at Brieg by a section descending the Lötschenthal at the Rhone Valley. The total length is 14,536 meters (9 miles), or but slightly shorter than the St. Gothard, though over 5,000 meters shorter than the Simplon, these being the only two existing tunnels by which it is exceeded. The length is nearly half a mile greater than was provided by the original scheme, a departure from the straight line having been necessitated by the catastrophe of 1908, which flooded the workings and entailed the loss of twenty-five lives, rendering nearly a mile of the boring useless. In spite of this delay, the piercing of the mountain, begun on October 15, 1906, occupied less than four and a half years, the rate of progress per day being greater than in the case of any of the previous great alpine tunnels, though closely approached in that of the Simplon. While not in any way affecting the communications between Paris and the south, and only in a minor degree those of the Rhine and southwest Germany, the new route will effect an appreciable shortening of the journey from London (and northeastern France) to Milan and other parts of Italy by the Calais-Belfort route, particularly when the projected tunnel, 4 miles long, under the Jura north of the Lake of Bienne has been completed; the saving will be most noticeable in the case of Genoa. The date fixed for the opening of the Lötschberg route, on which electric traction will be used, is May 1, 1913.

THAT the sulphur in our soils, hitherto considered of little importance to the fertility of the same, is of vast importance, and is also being rapidly depleted due to improper methods of agriculture, is the gist of a bulletin published by the University of Wisconsin, embodying the results of experiments conducted by Professor E. B. Hart and Mr. W. H. Peterson, of the department of agricultural chemistry. Sulphur has been considered relatively unimportant as compared with phosphorus and nitrogen content of soils. Tests made by Professor Hart and Mr. Peterson show, however, that low results were due to the analytical methods employed by the early investigators, and according to more accurate determinations the sulphur content of our soils is of vast importance. Continuous cultivation, in connection with insufficient fertilization, annually results in a heavy loss of sulphur. Combined with the losses of sul-

phur through drainage and the low original sulphur content of the soil, it appears that this loss can not be compensated by the sulphur obtained from the atmosphere. The surface eight inches of the normal soil contains only enough sulphur trioxide for about 100 normal crops of barley. The fact that the subsoil also has a low sulphur content, shows that the upward movement of capillary water can not bring much sulphur to the surface. In a word, it is necessary to apply fertilizers containing sulphur to maintain the crop yields of such soils. The conclusions derived from these experiments show that the sulphur content of a number of the common farm products, as previously determined, has been too low and that much sulphur trioxide is removed by crops from the soil—more than has been supposed. In fact, soils cropped continuously for half a century with infrequent applications of fertilizers have lost as high as 40 per cent. of their original sulphur.

At the suggestion of Dr. Paul G. Woolley, dean of the medical faculty of the College of Medicine of the University of Cincinnati, and with the active cooperation of Dr. John H. Landis, health officer, and Dr. William H. Strietmann, assistant health officer, the board of health of the city has voted that students of the college may have a complete service in all departments of the health department of the city. This cooperative work will begin in the junior year and each student will in his last two years complete a practical course in public health and sanitation. This work will include the usual chemical and bacteriologic work of health departments; water supply, and sewage disposal; disposal of the dead; sanitary, tenement, and house inspection; meat, vegetable and dairy inspection; school inspection and vaccination; tuberculosis field work including dairy work; and actual epidemiologic work including tracing of cases and sources of infection; and finally statistical work, and methods of making and filing reports.

There was an increase of $220,665,617 in the value of metals produced in the United States in 1909 over the value in 1908, as shown by an advance chapter from "Mineral Resources of the United States, 1909," on "The Production of Metals and Metallic Ores in 1908 and 1909," by Waldemar Lindgren, just issued by the United States Geological Survey. In 1909 the total production had a value of $870,445,230; that for 1908 was valued at $649,779,613. Pig iron led in 1909, both in quantity and in value, the output being 28,638,883 short tons, valued at $411,544,773, of which 27,689,883 tons, valued at $397,907,510, was derived from domestic ores. Refined copper, gold, silver and lead, in value of production, followed in the order named. Our own mines produced 57,449,584 short tons of iron ore in 1909, as against 40,301,336 short tons in 1908. Copper ores came next, with 28,025,092 short tons in 1909 and 22,358,857 tons in 1908; zinc and zinc-lead ores were next, with 10,679,608 short tons in 1909 and 8,157,963 tons in 1908; gold ores followed, with 9,241,827 short tons in 1909 and 8,991,751 short tons in 1908; lead ores were fifth in order of total production, with 5,811,687 short tons in 1909 and 5,082,853 short tons in 1908.

Nature announces that an International Association of Chemical Societies has been formed as the result of a conference of delegates from the chemical societies of England, France and Germany, held in Paris on April 5 and 26. The three leading societies of the countries named had been invited by the president of the Chemical Society of France to cooperate in this movement and to nominate delegates to represent their respective societies at the inaugural meeting. The representatives of the Chemical Society of London were Professor P. F. Frankland (president), Professor Meldola and Sir Wm. Ramsay. The Chemical Society of France was represented by Professors Béhal, Haller and Hanriot, and the German Chemical Society by Professors Jacobson, Ostwald and Wichelhaus. With the exception of Professor Meldola, who was unable to attend, all the delegates were present at the opening meeting, when the association was formally founded

and the statutes framed and adopted. From these statutes we learn that the objects of the association are to be promoted by the appointment of committees charged with the consideration and investigation of questions submitted by the council, by the publication of the results of such investigations and by the holding of conferences and congresses. It was decided at the opening meeting that the first international committees should be appointed for dealing with the questions of nomenclature in mineral and organic chemistry, and with the unification of the modes of stating physical constants. The next meeting of the association is to be held in Berlin on April 13, 1912, with Professor Ostwald as president, and the 1913 meeting is to be held in Great Britain.

UNIVERSITY AND EDUCATIONAL NEWS

The governor of Pennsylvania has approved a bill giving an appropriation to the Schools of Mines, Engineering, etc., of the University of Pittsburgh, amounting to $400,000.

Harvard University has received from the class of '86 $100,000 to be used without restriction for the purposes of the college.

President Taft, upon recommendation of the secretary of the interior, has forwarded to the senate the nomination of Professor Philander P. Claxton, professor of education in the University of Tennessee, as commissioner of education to succeed Dr. Elmer E. Brown, who recently resigned to accept the chancellorship of New York University.

Dr. Michael F. Guyer, of the University of Cincinnati, has been appointed professor of zoology in the University of Wisconsin.

Professor J. A. Ferguson, of the Pennsylvania State College, has been appointed professor of forestry in the College of Agriculture of the University of Missouri. The College of Agriculture owns fifty thousand acres of forest lands in the southern part of Missouri. It is planned to utilize these lands as an out-door laboratory for the instruction in practical forestry.

Frank Loxley Griffin, Ph.D. (Chicago), assistant professor of mathematics at Williams College, Williamstown, Mass., has been appointed professor of mathematics at Reed College, the new institution at Portland, Ore., which is to open September 18, 1911.

The Rev. Alan S. Hawkesworth has resigned from a lectureship in higher mathematics and semitic languages in the University of Pittsburgh.

Professor George D. Hubbard, head of the department of geology at Oberlin College, has charge of the work in geology and geography at Ohio State University during the summer session.

W. H. Longley, Ph.D., instructor in biology in Yale University, has been appointed assistant professor of biology in Goucher College.

William Cumming Rose, Ph.D., formerly assistant in the Sheffield Scientific School, Yale University, has been appointed assistant instructor in physiological chemistry at the University of Pennsylvania.

DISCUSSION AND CORRESPONDENCE

DOUBLE MATING OF SILK-WORM MOTHS

In Science for May 19, 1911, Professor Kellogg reports certain double mating experiments with silk-worm moths, of which he invites criticism. His account leaves one with the general impression of a "perturbation in the order of inheritance" due to the presence of spermatozoa furnished by two different males. Several possible explanations are suggested by Kellogg, none of which however is advocated. For example, he inquires:

> Do the eggs in double-mated females receive more than one spermatozoon and are these spermatozoa often the representatives of both races used in the double mating? Or can the egg be in any way influenced by the mere presence in the spermatheca of spermatozoa representing both of a pair of allelomorphic heritable characters? Can fluids carrying the spermatozoa have any influence during fertilization? Can the spermatozoa of one type influence those of the other type during their enforced companionship for several hours or days in the female spermatheca?

Admitting that our present knowledge would lead us to answer these various questions in the negative, Kellogg closes with the inquiry:

Then why should the order of inheritance in the silkworm moth be different in the generations after these double matings from the order in the generations following a single mating?

But is it? I think not. And since it would seem to be of doubtful wisdom to seek possible explanations for a fact which is not true, let us first make sure of the fact.

Kellogg presents his data without any attempt at analysis, and this fact I think has led him, as it naturally does the reader, to suppose that the ordinary Mendelian inheritance of cocoon color is in these matings much disturbed. Before any critical discussion of the data is possible they must first be classified. Comparison may then be made with the behavior of the same races in *single* matings, which Professor Kellogg himself has given us in part in his 1908 paper.

In agreement with Coutagne (1902) and Toyama (1906), Kellogg finds that the inheritance of cocoon color in silkworms follows in general the Mendelian laws of dominance and segregation. Yellow color usually dominates over white in crosses, but in the case of certain races the dominance is not uniform. Yellow dominates over white in part of the zygotes only, in the remainder white dominates over yellow. This fact was first observed and clearly recorded by Coutagne (1902), who, though at that time unacquainted with the Mendelian laws, presented clear and convincing evidence of their applicability in the cases studied by him. Discussing Coutagne's results in 1905[1] I pointed out the fact (which Kellogg seems to have overlooked) that in cases where yellow dominates in F_1, there occur in F_2 three yellows to one white, whereas, when white dominates in F_1, there occur in F_2 three whites to one yellow. In other words the character which behaves as dominant in F_1 continues to behave as dominant in F_2. Kellogg's experiments show this same result both in single and in double matings, as I shall presently point out.

[1] Carnegie Institution Publication, No. 23, p. 59.

It happens that Kellogg has used in his double mating experiments a white race (Bagdad white) which is sometimes dominant,[2] sometimes recessive in crosses with yellow, and this seems to have been the real reason why he thought the "inheritance perturbed" by double mating. As a matter of fact the perturbation is no greater in the double than in the single matings.

In 1908 Kellogg reported the results of six crosses of Bagdad white with Istrian yellow, which were carried through two generations, as shown in Table I. One of the seven original matings produced only yellow offspring, two produced only white, and four gave a mixed progeny consisting of 82 whites and 60 yellows. Six matings of F_1 yellows *inter se* produced in F_2, 117 whites : 350 yellows, or 1w : 3y. Six matings of F_1 whites *inter se* produced in F_2, 418 whites : 140 yellows, or 3w : 1y. In both cases, it will be observed, the character which dominated in F_1 was in F_2 approximately three times as numerous as the other, a consistent Mendelian behavior. Further, when white dominant in F_1 was mated with yellow dominant in F_1, the result was the production of both sorts in numbers approximately equal. Seven such matings produced, in F_2, 324 whites and 381 yellows, or 1w : 1.2y.

[2] Kellogg expressly recognizes (p. 784) the frequent behavior of Bagdad white as a dominant character in crosses with yellow in single matings, yet on page 788 makes the surprising statement: "After a double mating the whites of the F_1 generation mated with other whites of the same generation do not always produce whites. They may produce both yellows and whites." [Certainly! If white is dominant, it should behave in just that way.] Kellogg then continues: "Or this latent carrying of the yellow character by these presumably strictly recessive (white) carriers may not be manifest till an F_3 generation." Kellogg then proceeds to seek an explanation in the double mating of the mother, having forgotten apparently his express statement on page 784 that Bagdad white frequently behaves as a *dominant*, which fact would explain everything.

TABLE I. RESULTS OF SINGLE MATINGS OF BAGDAD WHITE WITH ISTRIAN YELLOW SILKWORM MOTHS

F₁ White	F₁ Yellow	F₂ Parents	F₂ White	F₂ Yellow
31	21	W × W	57	31
		W × W	51	18
		Y × Y	34	86
		Y × Y	7	42
		W × Y	26	40
		W × Y	36	29
10	9	Y × Y	11	26
		W × Y	54	56
		W × Y	67	45
all	0	W × Y[1]	41	66
31	21 }	W × W	85	26
10	9 }	W × W	86	33
		Y × Y	13	71
		W × Y	48	72
		W × Y	52	73
all	0	W × W	77	17
		W × W	62	15
0	all	Y × Y	24	64
		Y × Y	28	61
Summary		*6*W × W	*418*	*140*
		*6*Y × Y	*117*	*350*
		*7*W × Y	*324*	*381*

In double matings of these same races there is only this difference to be borne in mind; the egg may have been fertilized *either* by a sperm of the same race or by one of the other race. In the former case we should expect the F_1 individuals all to be like the mother, and *all to breed true in* F_2, whereas in case of a cross we should expect F_1 sometimes and F_2 always to consist of a mixed brood.

Kellogg reports six such double matings (Tables II. and III.), three of which gave all yellow F_1 broods (except for a single possible "straggler"); one mating gave only white F_1 offspring, while two gave both sorts in F_1. Seven pairs of F_1 whites (from a Bagdad white mother, Table II.) gave only whites in F_2 as well as in F_3. Clearly the egg of the Bagdad mother was in each of these cases fertilized by sperm of the same race. At any rate the behavior through three generations is exactly the same as in the pure Bagdad race and shows no "perturbation" whatever.

[1] From F_1 of last cross in Table I.

One other mating of F_1 whites *inter se* gave in F_2, 46 whites : 15 yellows, or 3w : 1y, as

TABLE II. RESULTS OF MATING BAGDAD WHITE FEMALES DOUBLY, VIZ., WITH BAGDAD WHITE AND WITH ISTRIAN YELLOW MALES

F₁ White	F₁ Yellow	F₂ Parents	F₂ White	F₂ Yellow	F₃ Parents	F₃ White	F₃ Yellow
15	57	W × W	11	0	W × W	all	0
		W × W	all	0	W × W	all	0
		W × W	all	0	W × W	all	0
		Y × Y	6	22	W × W	35	0
					Y × Y	0	24
		Y × Y	9	20	W × W	25	0
					Y × Y	12	21
		Y × Y	4	17	Y × Y	8	20
		W × Y	12	12	W × W	19	0
					Y × Y	10	17
		W × Y	16	20	W × W	6	0
					Y × Y	8	6
					W × Y	4	12
		W × Y	5	31	W × W	19	0
					Y × Y	0	9
41	0	W × W	59	0	W × W	all	0
		W × W	all	0	W × W	all	0
		W × W	46	15	W × W	all	0
					Y × Y	0	all
48	20	W × W	all	0	W × W	all	0
		W × W	all	0	W × W	all	0
		Y × Y	9	12	W × W	all	0
					Y × Y	0	all
		Y × Y	1	26	Y × Y	2	14
		Y × Y	12	28	W × W	15	1(?)
					Y × Y	0	50
		W × Y	40	16	W × W	28	29
					Y × Y	5	34
		W × Y	20	19	W × W	70	0
					Y × Y	6	9
0	29	Y × Y	8	25	W × W	all	0
		Y × Y	6	12	W × W	all	0
					Y × Y	6	9
		Y × Y	9	30	Y × Y	0	all
		Y × Y	4	19	Y × Y	5	29
Summary		*7*W × W	*all*	*0*	*7*W × W	*all*	*0*
		*1*W × W	*46*	*15*	*1*W × W	*all*	*0*
					*1*Y × Y	*0*	*all*
		*10*Y × Y	*68*	*211*	*6*W × W	*all*	*1(?)*
					*5*Y × Y	*33*	*93*
					*4*Y × Y	*0*	*all*
		*5*W × Y	*93*	*98*	*4*W × W	*all*	*0*
					*1*W × W	*28*	*29*
					*1*Y × Y	*0*	*9*
					*4*Y × Y	*29*	*66*
					*1*W × Y	*4*	*12*

we should expect the white F' individuals to do when produced by a *single* mating between the white and the yellow races used.

TABLE III. RESULTS OF MATING ISTRIAN YELLOW FEMALES DOUBLY, VIZ., WITH ISTRIAN YELLOW AND WITH BAGDAD WHITE MALES

F_1		F_2			F_3		
White	Yellow	Parents	White	Yellow	Parents	White	Yellow
1(?)	55	Y×Y	10	23	Y×Y	2	12
		Y×Y	13	28			
		Y×Y	10	24	W×W	4	0
					Y×Y	16	0
0	30	Y×Y	4	16			
		Y×Y	4	19			
Summary		5Y×Y	*41*	*110*	*1*W×W	*all*	*0*
					*1*Y×Y	*2*	*12*
					*1*Y×Y	*all*	*0*

Fifteen matings of F_1 yellows *inter se* (Tables II. and III.) gave in F_2 109 whites : 321 yellows, or 1w : 3y, exactly as in the corresponding generation following *single* matings of the same races.

Five matings of F_1 white with F_1 yellow (Table II.) gave 93 whites : 98 yellows, close equality of the two sorts, again *as in the single matings.*

Thus far we have no evidence of any departure in the double matings from Mendelian inheritance as strict as prevails in the single matings. If such departures occur they are to be found in the remainder of Kellogg's statistics, which are based on F_2 matings. No F_2 broods from single matings of the races under consideration are reported by Kellogg. Surely he has not overlooked the elementary fact that F_2 matings should on a Mendelian expectation produce a different result from the F_1 ones, yet on no other supposition can I account for the fact that Kellogg speaks of "irregularities" that occur with "non-Mendelian regularity." These "irregularities" of F_3 as compared with F_2 are not "non-Mendelian"; they are part of the Mendelian expectation as a moment's consideration will show. The F_1 individuals, whether yellows or whites, produced by a (single mating) cross of yellow with white are all heterozygous and so are expected to produce mixed broods, but of the F_2 individuals only *part* are heterozygous. The F_2 yellows from F_1 yellow pairs should be two thirds of them heterozygous like the F_1 yellows, but one third of them should be homozygous and so capable of producing all yellow broods. The same would be true also of the F_2 whites.

Kellogg reports seventeen matings *inter se* of F_2 yellows derived from F_1 ancestors, one or both of which were yellows. Six of these matings produced only yellow progeny indicating that the pair contained at least one homozygous yellow individual. One of the matings produced only white progeny, a surprising result if it is not a misprint. The remaining ten matings produced mixed broods, like those of the F_2 generation, aggregating 64 whites : 171 yellows, or 1w : 2.7y, a slight deficiency of yellows but no greater than the expected Mendelian deviations from the exact 1 : 3 ratio.

Let us now consider what is to be expected regarding F_2 whites mated *inter se*. If the egg of a Bagdad white female were fertilized by sperm of a Bagdad white male, we should expect F_1 and all subsequent generations from such fertilizations to contain only white individuals. Seven F_2 broods (Table II., summary) fall in this category as previously noted, being derived from seven different F_1 pairs coming from white F_1 pairs produced by a white mother doubly mated, but as regards these eggs evidently purely fertilized. These seven pairs produced only white offspring both in F_2 and in F_3.

In case the Bagdad white egg were fertilized by yellow sperm and gave yellow F_1 individuals which produced mixed broods, and white individuals from these broods were mated *inter se,* we should expect them to produce only white offspring, white being the recessive character in such cases and so presumably pure. Six of the F_2 white pairs (Table II.) fall in this category and produce only white F_3 offspring, except for one individual possibly a yellow "straggler," as suggested by Kellogg.

In case the F_2 white individuals were derived from a *crossed* (and so *dominant*) white F_1 individual mated with a yellow one likewise a dominant heterozygote, we should ex-

pect such F_2 whites to be in part heterozygous, but in larger part homozygous, and of these homozygotes some should be *dominant* whites. Now a homozygous dominant white individual, however mated, should produce only white offspring, and only occasionally would a *pair* of *heterozygous* dominant whites be secured, the condition necessary to allow yellow to recur in F_3. But we must remember that *homozygous* whites as well as heterozygous ones occur in F_1. Therefore matings of F_1 whites selected at random with yellows all known to be heterozygous should produce in a probable majority of cases white F_1 progeny which would be homozygous. Two of these mated together should, of course, breed true in F_3. Accordingly we expect pairs of F_2 whites in most cases to produce only white F_3 offspring. Kellogg records five F_2 matings of whites from white × yellow F_1 pairs (see Table II.). Of these, four produced only white F_3 individuals but one produced a mixed brood of 28 whites and 29 yellows.

Let us next consider what is to be expected from yellow × yellow F_2 pairs derived from white × yellow F_1 parents. The F_1 whites, as we have seen, are often homozygous. Therefore F_2 yellows descended from them are pretty sure to be heterozygous and should in general produce mixed broods. Kellogg records five such matings (see Table II.), four of which gave mixed broods aggregating 29 whites : 66 yellows, or approximately 1w : 2.3y. The fifth brood produced 9 offspring, all yellow. From so small a number it is impossible to decide whether one or both parents were homozygous in yellow, as seems probable. It is evident, however, that the great majority of the F_2 yellows of this origin are, as expected, heterozygous.

Finally mention should be made of a mating of F_2 yellows derived from white F_1 parents, which produced only yellow young in F_3. This seemingly contradictory result exactly accords with Mendelian expectation, for in this cross yellow was *recessive* in F_1, therefore upon reappearing in F_2 it should be *homozygous* and so breed true.

At every point, in this series of experiments, the Mendelian expectation is realized, not only in F_2, but also in F_3, if we base that expectation on the behavior of the same races in the single matings made by Kellogg. It is therefore idle to seek for explanations of "perturbed inheritance" due to double matings where no perturbation is discoverable.

In a second series of double matings made by Kellogg, the same white race (Bagdad) was

TABLE IV. RESULTS OF MATING FRENCH YELLOW FEMALES DOUBLY, VIZ., WITH FRENCH YELLOW AND WITH BAGDAD WHITE MALES

F_1		F_2			F_3		
White	Yellow	Parents	White	Yellow	Parents	White	Yellow
57	74	Y × Y	8	22	W × W	all	0
					W × W	all	0
					Y × Y	0	all
					Y × Y	9	20
		Y × Y	5	14			
		Y × Y	2	23			
		W × Y	19	17	W × W	26	12
					W × W	19	6
		W × Y	17	21			
14	140	W × W	30	10	W × W	62	0
		W × W	20	10	W × W	"some"	"some"
					Y × Y	2	12
		Y × Y	2	18	Y × Y	1	4
		Y × Y	0	59	Y × Y	0	47
		W × Y	18	14	W × W	29	11
					Y × Y	3	1
		W × Y	10	10	W × W	93	25
					Y × Y	8	35
0	90	Y × Y	3	13	Y × Y	0	all
		Y × Y	8	17	Y × Y	6	10
Summary		*2*W × W	*50*	*20*	*1*W × W	*all*	*0*
					*1*W × W	*"some"*	*"some"*
					*1*Y × Y	*2*	*12*
		*6*Y × Y	*28*	*107*	*2*W × W	*all*	*0*
					*2*Y × Y	*0*	*all*
					*3*Y × Y	*16*	*34*
		*1*Y × Y	*0*	*59*	*1*Y × Y	*0*	*47*
		*4*W × Y	*64*	*62*	*4*W × W	*167*	*54*
					*2*Y × Y	*11*	*36*

employed together with "French yellow." In three matings (Table IV.) the French yellow female was used, and in the same number of cases (Table V.) the Bagdad white female was used. In each case the female was mated both with a male of her own race and with

one of the other race, as in the crosses with Istrian yellow.

In one case the French yellow mother produced only yellow offspring. This was evidently due to complete dominance of yellow in the cross, for white descendants were obtained both in F_2 and in F_3. In the two other broods produced by French yellow mothers, both white and yellow individuals occurred in F_1, so that dominance here alternated between yellow and white.

The reciprocal cross (Bagdad female × French yellow male, Table V.) gave a similar result. In one case, white was completely dominant; in the other two, mixed broods were obtained.

TABLE V. RESULTS OF MATING BAGDAD WHITE FEMALES DOUBLY, VIZ., WITH BAGDAD WHITE AND WITH FRENCH YELLOW MALES

F_1		F_2			F_3		
White	Yellow	Parents	White	Yellow	Parents	White	Yellow
all	0	W × W	111	44	W × W	all	0
					Y × Y	8	40
					Y × Y	9	29
		W × W	all	0	W × W	all	0
					W × W	15	2
		W × W	all	0	W × W	14	0
					W × W	17	4
25	13	W × W	1:	1	W × W	all	1(?)
					Y × Y	1	a few
		W × Y	1:	1	W × W	23	2
33	19	W × W	all	1(?)	W × W	all	0
		Y × Y	1:	1	W × W	9	1
		W × Y	22	0	W × W	a few	0
		W × Y	6	10	Y × Y	1:	1
Summary		*3*W × W	*all*	*1*(?)	*3*W × W	*all*	*0*
					*2*W × W	*32*	*6*
		*2*W × W	*111*	*44*	*2*W × W	*all*	*1*(?)
					*1*Y × Y	*1*(?)	a few
					*2*Y × Y	*17*	*69*
		*1*Y × Y	*1*:	*1*	*1*W × W	*9*	*1*
		*1*W × Y	*22*	*0*	*1*W × W	*a few*	*0*
		*2*W × Y	some	some	*1*W × W	*23*	*2*
					*1*Y × Y	*1*:	*1*

F_1 yellows from a French yellow mother were mated *inter se* in seven cases. One of the seven pairs produced only yellow F_2 offspring, 59 in number, and a pair of these gave, in F_3, 47 offspring all yellow, which result indicates that one or both of the F_1 yellows in this case were pure, being derived from a fertilization by sperm of the French yellow male. The remaining six pairs of F_1 yellows produced mixed F_2 broods aggregating 28 white : 107 yellow, or 1w : 3.8y, a small excess of yellows. Four matings of F_1 yellows with whites (Table IV., summary) produced mixed broods, aggregating 64 whites : 62 yellows, or 1w : 1y, as in similar matings (single or double) of Bagdad with Istrian yellow. Two matings of F_1 (dominant) whites from a French yellow mother (Table IV.) produced 50 whites : 20 yellows, where 3w : 1y are expected. In the reciprocal cross (Table V.) F_1 whites produced in two cases white offspring only and in a third case all white but one individual, a possible straggler, while two other pairs gave mixed F_2 broods. In case of the two F_1 pairs which produced only white F_2 offspring, it is evident that only one of the white parents can have been pure (derived from a white × white fertilization), for yellows were obtained in F_3 in three of the four matings made. Matings of F_1 whites with F_1 yellows were made in three cases, two of which produced mixed broods of approximately 1w : 1y; in the third mating the white was apparently pure (from a white × white fertilization), for the 22 F_2 offspring were all white, as were also the "few" F_3 offspring descended from them.

So far there is encountered nothing at variance with Mendelian expectation. But among the F_3 broods derived from this cross (Table V.) occur some minor irregularities. However, the numbers in these broods are in general very small, so that this part of the series can not be regarded as very satisfactory. The chief irregularity occurs among the F_3 progeny of a cross which had given whites only in F_1 and 111w : 44y in F_2, a consistent behavior of white as dominant. A pair of the F_2 whites produced an all white F_3 brood, also a consistent result, but two pairs of the F_2 yellows produced *mixed* F_3 broods, viz., 17w : 69y where we should have expected only yellow progeny in accordance with the *recessive* behavior of yellow in the two previous generations. (Compare the reciprocal cross,

Table IV., where this expectation is realized.) Dominance here has apparently shifted from the white to the yellow character. It would be a matter of great interest to know how the character would behave in later generations and whether the altered dominance may not be due to some independent factor interchangeable between white and yellow. We get no evidence of such a condition elsewhere in Kellogg's experiments, and the numerical proportions of the yellows and whites in these two broods are a slender basis on which to base such a hypothesis, but these two broods would form a good starting-point in looking for an explanation, if they were followed into later generations.

Kellogg's experiments seem to the writer to be of value not in respect to their double mating feature, which really has produced nothing at variance with the results of single matings, but in their demonstration, in common with Coutagne's experiments, of varying dominance, a matter as yet quite obscure and affording inviting material for further study. It is to be hoped that Professor Kellogg will not fail to put on record the further data mentioned in his paper.

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June 7, 1911

WHAT IS WHITE AND BLACK ALKALI?

THE popular distinction between "white" and "black" alkali salts in soils is of considerable practical importance, and anything that tends to confuse the farmers' ideas in this respect is regrettable; doubly so when official publications of experiment stations or the Department of Agriculture at Washington lend countenance to such confusion. The cultivation and reclamation of lands affected by alkali salts is comparatively simple when the alkali is "white," but always more risky and difficult when these are "black," and in the latter case are sometimes economically impracticable.

In a general way, black alkali is sodium carbonate, which after dissolving the humus of the soil, leaves black spots on the land where the solution has evaporated; while white alkali leaves only the white crust of the sulfate and chloride of sodium. Broadly speaking, the sulfate is quite four times less injurious to vegetation than the carbonate, while common salt stands in between in this respect.

Some years ago, it was stated in an official publication, that an observer had "discovered" that bicarbonate (hydrocarbonate) of sodium was frequently present in alkali salts; and as laboratory experiments had shown that the bicarbonate was not more injurious than the other two "white" salts, it should, therefore, be considered as part of the latter. And having been the first to investigate alkali lands in this country, I have been censured for overlooking such obvious facts, giving lands containing the bicarbonate an undeserved bad name.

Now any one familiar with the occurrence and behavior of the three sodium carbonates —the normal or monocarbonate, the sesquicarbonate (so-called) or trona, and the hydro- or bicarbonate, can readily understand the reason why I have considered the presence of either of these compounds in the soil equivalent to that of the others. The only one of them that occurs as a mineral in nature, and is stable under natural conditions, is the sesquicarbonate, occurring as trona wherever a solution of either of the other two evaporates spontaneously in the presence of atmospheric air. The monocarbonate absorbs carbonic dioxide from the air whenever exposed, so that when we want to obtain an accurately weighed quantity of the normal carbonate, we must first ignite it. On the other hand, the bicarbonate begins to lose carbon dioxid as soon as exposed to moist air, and upon evaporation its solution leaves a residue of sesquicarbonate, which acts practically as though it contained the normal carbonate, in dissolving humus, causing injury to vegetation, and puddling the soil.

It is thus obvious that, supposing a soil to contain a solution of bicarbonate only, the latter will, so soon as it is raised to the sur-

face by capillarity, at once begin to lose carbon dioxid, leaving a residue of sesquicarbonate; which will, without difficulty, dissolve the humus of the soil, and act in other respects precisely like the normal carbonate.

In view of the fact that the air of the soil always contains more carbonic dioxid than the air, any sodic carbonate it contains in solution will inevitably suffer transformation into bicarbonate to the extent to which carbonic acid happens to be found in the soil under the existing conditions of vegetable growth, temperature, moisture, and bacterial action in the oxidation of organic matter. It is a matter purely of seasonal accident; so that, if a soil sample happens to be taken at a time when carbon dioxid is abundantly forming, the chemist may find in it exclusively bicarbonate; while similar samples, taken a few weeks afterwards, may under the influence of aeration and drying, be found to contain, in the main, the sesquicarbonate.

I have therefore considered, and do now consider, the determination of *sodium bicarbonate* in the soils as quite immaterial for practical purposes, it being a variable and entirely uncertain factor; and inasmuch as ultimately the entire amount of sodic carbonates may serve for the formation of sesquicarbonate and the normal salt, I have thought best to calculate the entire amount of these carbonates found to the latter salt, without reference to the other two.

Of late, the official characterization of the hydrocarbonate salt as no more harmful than other white alkali, has led some chemists analyzing irrigation waters to recommend for that purpose, waters containing considerable amounts of sodium bicarbonate. In this case, the prospect of the accumulation of indefinite amounts of black alkali in the soil irrigated would be such a positive and inexcusable detriment, that it seems high time to put an end to the misleading statement which leads chemists, as well as farmers, to expose lands to serious injury.

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Berkeley, Cal.,
June, 1911

METALS ON METALS, WET

It is generally agreed that the coefficient of friction between metals (outside the physical laboratory) is a very elusive quantity. It is with the hope of suggesting some considerations not mentioned by Professor Hall[1] but of great practical importance that the following comments are offered.

The difference in coefficient of friction between driving wheel and rail, whether the latter is wet or dry, is relatively immaterial so far as the effect of using sand to prevent the slipping of the driving wheels is concerned. Sand is used on dry as well as wet rails, with a similar result in either case, namely, to increase the coefficient of friction between wheel and rail. The reason for this is obvious, since the sand particles become ground between the two surfaces, giving them, in effect, the roughness which greatly increases the coefficient of friction over that of the unsanded smooth surfaces.

It is also well known to railroad engineers that a cleanly washed wet rail, as after a heavy rain, is a "better" rail and is less likely to result in slipping of wheels than a perfectly dry rail. Of course a rail having slimy water or any foreign matter, such as coal dust, frost, etc., which can act as an ungent, results in lowering the coefficient of friction. It is because a wet rail is ordinarily greasy that sand is commonly used when the rail is wet, whereas, a dry rail is more apt to be gritty, due to the dust, etc. There is therefore less necessity for using sand.

Referring to Professor Hall's paragraph one, would not term "adhesion"[2] apply to the phenomena mentioned more accurately than term "friction"? A similar effect is noticed when a thin film of water separates two plates of glass.

Professor Hall's conclusion would seem to satisfactorily account for one phase of the problem, but, as stated above, the phenomenon

[1] Science, May 19, 1911, p. 775.

[2] See DuBois, "Mechanics of Engineering," Vol. 1, p. 220.

of friction, especially as it is met with in actual practise, is a most complex and elusive factor and in attempting to evaluate its effect or satisfactorily account for its mutations it is not safe to overlook any of the possible influences affecting the final results.

Since 1878 it has been known that Morin's laws regarding friction are absolutely unreliable except within a limited range of conditions. With heavy unit pressures between contact surfaces, such as exist over the small area of contact between driving wheel and rail or between a brake shoe and the wheel to which it is applied with the forces required to stop a modern passenger car under present-day service conditions within a reasonable distance, the coefficient of friction may fluctuate through wide ranges, due to the combined influence of pressure, relative speed of contact surfaces, temperature, continued rubbing and so on. For example, with cast-iron brake shoes on steel-tired wheels the effect of speed has been found to reduce the coefficient of friction from 33 per cent. when just moving, to less than 10 per cent. when at a speed of 60 miles per hour.

This subject is far too broad to warrant further discussion in such a communication as this, but any who may be interested in the experimental results obtained, and the conclusions drawn therefrom, are respectfully referred to papers presented before the British Institute of Mechanical Engineers, June and October, 1878, and April, 1879, by Captain Douglas Galton, describing the classic Westinghouse-Galton experiments on the effect of brakes on railway trains and a paper by Mr. R. A. Parke, in the *Railway Gazette* for June 14–21, 1901, entitled "Friction of Brake Shoes." Copies of the above will be gladly furnished gratis on application to the Westinghouse Air Brake Company, Wilmerding, Pa.

S. W. DUDLEY

QUOTATIONS

ADMISSION TO HARVARD COLLEGE

THE new alternative plan of admission to Harvard College, announced to the schools only a few months ago, was given its initial test at the entrance examinations of last week. The results, so far as one may judge at this early date, were in every way distinctly promising. Over one hundred candidates for admission took advantage of the new provisions, which seems to warrant a belief that the schools already realize the possibilities of the scheme as a method of getting their best pupils into Harvard, and that if this year's results prove satisfactory the number of applications for entrance under the alternative arrangements will show a large increase next year.

Even more significant, moreover, is the fact that of these hundred candidates more than half are from schools outside New England. It was precisely to this constituency—the public high schools outside New England—that the new plan was meant to be of service. It was devised primarily as a means of admitting to Harvard bright boys from distant schools who had pursued good four-year preparatory courses, but who had not been hammered into the particular grooves marked out by the old entrance requirements. The schools of New England, whether public or private, find no very great difficulty in meeting these requirements, and many of them, doubtless, will continue to send their boys along the old route. But the public high schools of the middle states, the west and the south have hitherto found the task of fitting boys for Harvard to be much more difficult, and it was to them that the framers of the new admission plan hoped to afford relief. These schools have responded in the most encouraging fashion at the very outset.

It will not, of course, be possible to draw any definite conclusions concerning the quality of the students admitted under the new requirements until they have passed a year or two in the college, side by side with students who have come to us under the old provisions; but the testimony of those who have been reading the examination books indicates that there is every ground for optimism in this

regard. The schools seem to have met the new arrangements with cordiality and good spirit.—*Harvard Alumni Bulletin.*

SCIENTIFIC BOOKS

Reports to the Local Government Board on Public Health and Medical Subjects (New Series, No. 53). Further Reports (No. 4) on Flies as Carriers of Infection. Pp. 48. Bacon Street, E., London, Darling and Son, Limited. 1911.

This latest number of this very valuable series of reports on flies as carriers of infection includes four articles of cosmopolitan interest: Dr. Copeman, Mr. Howlett and Mr. Merriman report upon an experimental investigation in the range of flight of flies; Mr. Austen presents a memorandum on the result of examinations of flies from Postwick Village and refuse deposit; Dr. Nicoll discusses the part played by flies in the dispersal of the eggs of parasitic worms, and Dr. Graham-Smith gives further observations on the ways in which artificially infected flies carry and distribute pathogenic and other bacteria.

The investigation on the range of flight of flies, by Dr. Copeman, Mr. Howlett and Mr. Merriman, is of great importance and is one which is very difficult to carry to a practical conclusion. Its value in deciding, in practical anti-fly work, the distance from a given point to which it is necessary to carry the abolition of possible breeding places is fundamental. It necessitates the use of a method of marking flies which will not interfere with their normal habits, and can at the best indicate only certainties of observation. It is shown in this report that marked flies in the series of observations were recovered at distances varying from 400 yards to 1,408 yards from the point where they were marked, thus indicating a flight of more than three quarters of a mile. The writer of this notice, in his recently published book "The House Fly—Disease Carrier," brought together all of the previously recorded observations on this point, but was unable to find any substantial records of distances equal to this. While it is true that the probabilities strongly favor a more extended flight, these observations nevertheless record the longest scientifically observed flight and indicate that for at least three quarters of a mile around a given point breeding places must be treated or abolished if the nuisance and danger of the house fly are to be avoided. It should be stated that, in the text on page 8, a distance of 1,700 yards is indicated, but this does not appear in the table. Accepting 1,700 yards, the observed limit of distribution reaches nearly a mile. The authors note that the direction of the prevailing wind is an important factor, and that the time of the distribution observations was forty-eight hours.

Dr. Nicoll, in his consideration of the part played by flies in the dispersal of the eggs of parasitic worms, shows that flies may convey such eggs from excrement to food in two ways, namely, on the external surface of the body and in the intestine. The latter mode occurs only where the eggs are of small size (under 0.05 mm. in diameter). Larger eggs may be carried on the external surface, but these are usually removed by the fly within a short time. Others which are taken into the intestine may remain there for two days or longer, and may remain alive and subsequently cause infection. The eggs of the following parasitic worms have been shown experimentally to be capable of being carried by *Musca domestica: Tænia solium, Tænia serrata, Tænia marginata, Hymenolepis nana, Dipylidium caninum, Dibothriocephalus latus* (?), *Oxyuris vermicularis, Trichuris* (*Trichocephalus*) *trichiurus,* both internally and externally; *Necator americanus, Ankylostoma caninum, Sclerostomum equinum, Ascaris megalocephala, Toxascaris limbata* (=*Ascaris canis* e. p.), *Hymenolepis diminuta* externally only. No Trematode parasites have as yet been experimented with in this investigation.

Dr. Graham-Smith concludes that both house flies and blow-flies are capable of infecting fluids, such as milk and syrup, on which they feed and into which they fall. In the case of the house fly, infected with certain micro-organisms (*B. prodigiosus* and *B. anthracis*), gross infection may be produced in

milk for at least three days, and a smaller degree of infection for ten days or even longer. At the same time he shows that blow-flies produce gross infection for six to nine days with non-spore-bearing micro-organisms and some degree of infection for three or four weeks. The investigator thinks that it is probable, at any rate in the later stages, that infection is mainly due either to direct infection with the crop contents vomited through the proboscis, or to direct infection by means of the limbs which have been reinfected with vomited material.

These experiments were so conducted as to afford no information as to the extent to which house flies bred from larvæ fed on naturally infected excreta and similar materials are apt themselves to be infected.

L. O. HOWARD

Lectures on Fundamental Concepts of Algebra and Geometry. By J. W. YOUNG. Prepared for publication with the cooperation of W. W. DENTON, with a note on the growth of algebraic symbolism by W. G. MITCHELL. Pp. vii + 247. New York, The Macmillan Company. 1911.

While the teacher of secondary mathematics finds a large amount of English literature on the teaching of his subject he looks in vain for much that is well adapted to give him a deep insight into the fundamental theory of the subjects with which he has to deal. The English language contains no encyclopedia on elementary mathematics like Weber and Wellstein's "Enzyklopädie der Elementarmathematik," or like the new Italian encyclopedia which is being prepared. It has no histories like Cantor's or even like Tropfke's. It has no periodical like *L'Enseignement Mathématique,* and no large mathematical encyclopedias like the great works which are now being published in German and in French.

Although the small size of the book under review precludes any hopes that we might have here a work to which the teacher of secondary mathematics may turn for an answer to most of his questions, yet he will find here an unusually clear exposition of a large number of things relating to the logical foundation of algebra and geometry. The brevity of the exposition will doubtless be welcomed by many who are looking for a first general survey of some basic matters, and it is to be hoped that they may become sufficiently interested to pursue the thoughts further, as they are encouraged to do by a fair number of references.

The book is modern in spirit, and, to a large extent also, in subject matter. Considerable attention is given to historical settings but the logical element receives the greatest emphasis. It opens up view points which are of great interest even if they may not always be acceptable to the reader. From the nature of the case many of the questions treated are such as to give rise to different views, but their fundamental importance justifies inquiries even if these do not always receive a complete answer. One of the most important lessons for the young mathematician to learn is a keen realization of the narrow limits of the explored parts of mathematics as compared with those regions which invite our inquiry and baffle our efforts.

The contents of the volume can be readily inferred, in the main, from its title. After a brief consideration of Euclid's elements and non-euclidean geometry, the author considers the logical significance of definitions, axioms and postulates, the consistency, independence and categoricalness of a set of assumptions. This is followed by a consideration of the fundamental notions of class, correspondence and group, and the development of the concepts of real and complex numbers. It is pointed out that from the abstract point of view algebra and geometry are identical in the sense that each includes the other, and that this explains the interrelations between these subjects.

On page 194 the author repeats a historical error which is very wide spread in mathematical literature, as regards the early use of the term function for integral power of a variable. This error seems to have been started by d'Alembert and it has been re-

peated by a large number of prominent mathematicians.[1] That the graph on page 214 is the graphic representation of the function in question is open to serious doubts, which should not have been passed over in a work on logical foundations. The statement on page 101 that "Diophantus of Alexandria. who lived 300 A.D., seems to have been the first actually to have made use of rational numbers" is apt to mislead the reader even if a footnote helps to ascertain the author's meaning. Taken by itself this statement seems absurd.

These are, however, matters of secondary importance and the book under review seems to be remarkably free from errors if we consider its wide scope. In particular, the proof seems to have been read with unusual care and one can only wish that the book will be very widely read, especially by those who are preparing to teach secondary mathematics. Its style is attractive and many of the questions which it treats are so far reaching that one may reasonably expect that it will find a considerable number of readers outside of the circle of professional mathematicians.

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[1] Cf. "Encyclopédie des Sciences Mathematiques," Tome 2, Vol. 1, p. 3; Cantor's "Geschichte," Vol. 3, 1901, pp. 215, 456–7.

SPECIAL ARTICLES

COLOR DISPERSION IN THE ASTIGMATIC EYE

When an astigmatic eye views a bright point of light in which only the rays near the ends of the visible spectrum are present, the image of the source is blurred by fringes or wings of red and blue. If the eye has a well-defined axis of astigmatism but is otherwise fairly emmetropic, the appearance of such a source is so curious as to compel attention. The purplish image is then crossed by a pronounced red band parallel to that meridian of the eye in which the curvature is least, and by a blue band at right angles to it. In the case of astigmatism with the rule, the red band is approximately horizontal. The experiment is easily tried in a darkened room by allowing the light from a flame or electric lamp to pass through a hole a few millimeters in diameter in a screen, or better by placing the lamp in a box having a small hole in one side. One or two thicknesses of common "pot blue" glass are placed over the opening, which is then viewed from a distance of two meters or more. The blue glass, as is well known, is fairly transparent to red light. Distant blue lights seen at night, such as the "dwarf signals" in railroad yards, show the effect well.[1] Indeed, the appearance can be seen by viewing any bright light through a blue glass held in front of the eye. A person free from astigmatism can see the effect by holding a cylindrical lens in front of the eye.

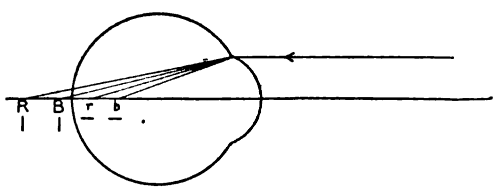
The explanation is simple, and has very likely occurred to many who have noticed the effect. However, the writer has been unable to find any reference to it, either in the classical memoirs of Helmholtz and his predecessors, or in such later writings as he has access to. Astigmatic vision seems to have been considered only on the tacit assumption that dispersion could be neglected—an assumption that is sufficient with ordinary white light, in which the yellow and green rays predominate in determining our visual sensations. It is only when these intermediate rays are excluded that the effects of dispersion become noticeable.[2]

Taking the type of astigmatism most commonly found, let us assume that the radius of curvature of the cornea is less for the vertical than for the horizontal meridian. If the eye observes a distant point-source giving only

[1] Among those whom the writer asked whether they had noticed the crossed red and blue bands was a certain railroad employé, who not only observed the appearance to a marked degree, but also volunteered the explanation that the dwarf signal "had a dirty glass." Remarks of this sort show how unconscious we are of our own defects of vision.

[2] For example, Helmholtz describes some interesting experiments on the effects of chromatic dispersion in the eye; these are also recounted by Lummer in Müller-Pouillet's "Lehrbuch der Physik." In all these cases the eye is assumed to be free from astigmatic defects.

red and blue rays, then the foci for these rays with respect to the curvature of the vertical meridian will fall, say, at r and b, while the foci with respect to the curvature of the horizontal meridian will fall at R and B respectively. The relative distances are exaggerated for the sake of clearness. Helmholtz gives the distance between the focal planes for red and violet (RB or rb in the diagram) as about 0.6 mm. Whether r falls to the right or left of B depends on the degree of astigma-



tism. In an otherwise emmetropic eye focused on infinity the retina will be somewhere between the points B and r. If the accommodation is such that the point R falls on the retina, the eye perceives instead of a point a vertical red band. The direction of the bands is indicated by short lines under the letters in the diagram. A horizontal blue band is perceived if the point b falls on the retina, in each case the band being surrounded by an indistinct halo due to the other images. If B and r fall close enough to the retina, R and b will be out of focus and practically indistinguishable, so that only a horizonal red band crossing a vertical band of blue will be seen. While the writer normally sees these bands crossing, he is able, by changing the accommodation of the eye, to observe the vertical red band (surrounded by a bluish halo) or the horizontal blue band. To see the two bands crossing, the degree of astigmatism must, of course, fall between certain limits, but these limits turn out to be surprisingly wide, partly because the appearance of crossed bands is heightened by the effects of contrast, partly because the bands become longer with increasing astigmatism. As would be expected, the red band *looks* nearer than the blue.

As for the quantitative relations, it is easy to show that there is a degree of astigmatism, well within the limits commonly found, for which the crossed red and blue bands are in focus simultaneously. For Helmholtz, as stated above, shows that the distance RB between the focal lengths for red and blue due to dispersion is about 0.6 mm. On the other hand, in an astigmatic eye the difference between the focal lengths due to the two curvatures at right angles (Rr or Bb) may be anything from zero to 2 mm. or more. Thus an eye need be only slightly astigmatic (correction about 1.5 diopters) in order to bring the points B and r into coincidence.

If the eye has an astigmatism so complex that several astigmatic axes in different planes have to be dealt with, the red and blue bands are correspondingly complex. Indeed, this method might perhaps prove useful in the examination of astigmatic eyes. By placing cylindrical lenses of varying focal lengths before the eye, it is possible to tell by the disappearance of the bands when the optimum correction has been attained. It may be remarked in passing that the phenomenon of color dispersion furnishes an interesting demonstration of the manner in which ametropia is corrected. For, as is well known, far-sighted and near-sighted eyes perceive purple sources as surrounded by a red or a blue halo respectively, and this halo can be increased, or reduced to a well-marked minimum, by the use of suitable spherical lenses.

Even a small source of *white* light looks a little ruddier on two opposite sides if the eye is astigmatic.

Very peculiar effects are produced in an astigmatic eye by repeating the experiments described above with a purple or "blue" light, using in place of a round hole a row or group of pinholes, or a slit, or a maltese cross set at varying angles.

To show the crossed red and blue bands objectively, an astigmatic lens of high dispersion was made in the following manner: the surface of a large incandescent bulb was tested at different points, until a region was found where the ratio of the curvatures in planes parallel and at right angles to the axis of the bulb was of the desired value (a 60-

watt tungsten lamp was the largest available giving the required ratio). This ratio was computed from a consideration of the wave-lengths transmitted by the blue glass used, namely, about 710 and 420 $\mu\mu$, and of the indices of refraction of carbon disulphide for these wave-lengths. This part of the bulb was cut out, forming a sort of shallow bowl into which a quantity of carbon disulphide was poured. I thus had an astigmatic plano-convex lens which gave as an image a minute red-and-blue cross when purple light was passed vertically through it. Later the fragment of the bulb was cemented with shellac on to a flat piece of glass, forming a cell into which the carbon disulphide could be introduced. A diagram was used to screen off all but a small portion of the lens.

In a rudimentary way the appearance can be projected on to a screen by passing light obliquely through a common plano-convex lens.[3]

W. G. CADY

WESLEYAN UNIVERSITY

[3] I am indebted to Professor Raymond Dodge for this suggestion.

THE IOWA ACADEMY OF SCIENCE

THE sessions of the academy were held in Carnegie Science Hall, Coe College, Cedar Rapids, April 28 and 29.

The public address by Dr. Edward L. Nichols, of Cornell University, on "The Ends of the Spectrum—the Infra-red and the Ultra-violet," was given on Friday at 8:00 P.M.

Sessions of the academy for the reading of papers were open to the public.

Nitrogen in Rain and Snow: NICHOLAS KNIGHT.

Seventeen samples of rain and snow were collected on the college campus at Mt. Vernon, Iowa, during nine months of the year 1909–1910. The nitrogen in the free and albuminoid ammonia and in the nitrates and nitrites was determined. Comparisons were made of the relative amounts of nitrogen precipitated with the rain and snow. According to the experiments, each acre would receive in the nine months between thirteen and fourteen pounds of nitrogen from the rains and snows.

Perchloric Acid in Electro-chemical Analysis: W. S. HENDRIXSON.

Asteroid, 1909, JA: SETH NICHOLSON and ALMA STOTS.

Vaccination against Typhoid Fever: HENRY ALBERT.

The writer briefly reviewed the experimental work on immunization with cultures of typhoid bacilli, then gave the technique and preparation of vaccine as generally employed at present for the preventive vaccination against typhoid fever. The reaction was divided into a local one which disappears in the course of a few days and a general one which he divided into leucocytic, phagocytic, agglutinitic and bacteriolytic. There is an increase in the number of leucocytes, the power of phagocytosis, and of the agglutinins and bacteriolysins in the blood serum. The presence of immune bodies may be demonstrated as long as one year after vaccination and is of both a higher degree and of longer duration than usually occurs following an attack of typhoid fever. Reasoning from analogy from the protection afforded by one attack of the disease, he believes that the immunity conferred by vaccination exerts more or less protective influence throughout the life of an individual. He would extend antityphoid vaccination to all liable to exposure to infection with typhoid fever.

Flowers of Story County: J. M. LINDLEY.

The Succession of Floras on the Sand Dunes of Iowa: B. SHIMEK.

A discussion of the changes of the earliest flora of these dunes, consisting largely of leguminose plants, to the typical prairie flora of the older areas.

The Nebraskan Drift: B. SHIMEK.

A discussion of its distribution and correlation, including the results of recent investigations. The conclusion is reached that this drift can not be correlated with the Jerseyan and Albertan, and that the name "Kansan" should not be transferred to it.

Notes on Fungus Diseases: L. H. PAMMEL.

Gives a record of a very destructive *Exoascus* upon the hard maple in the Rocky Mountains, also an account of the destructive *Exoascus* on the oak, the destructive *Fomes iginarius* on the quaking aspen in some parts of the Wasatch Mountains in Utah, as well as the destructive work of *Pleurotus* upon the box elder and other deciduous trees in Iowa.

An Abnormal Carpel in Stenospermatium: J. E. GOW.

Notes in Regard to Efficiencies of Luminous Flames: G. W. STEWART.

An investigation of the efficiency of luminous flames would be of interest. Results obtained incidentally were studied, showing that a cylindrical acetylene flame is not so efficient as a flat acetylene flame when judged by the proportion of its radiant energy that is visible. The amount of visible radiant energy that a given quantity is able to furnish should also be considered. Experiments with a flat kerosene flame show a height of flame at which the candle-power-hours-per-gram is a maximum. The problem of obtaining the most efficient flame, in the broadest sense, is complex. It is advisable to get the temperature of the incandescent particles as high as possible, and also to get as many of them per gram of the illuminant as possible. Both of these factors depend upon the shape of the flame.

On the Rate of Recovery of the Elastic Properties of a Certain Wire: L. P. SIEG.

The Measurement of Musical Capacity: C. E. SEASHORE.

The speaker outlined a series of measurements and statistics for a quantitative determination of musical capacity. The principal measurements are on pitch discrimination, perception of consonance and dissonance, tonal memory, tonal imagery, discrimination for intensity of sound, the appreciation of rhythm, rhythmic action and voluntary control of pitch of voice. These exact measurements were supplemented by returns to an elaborate questionnaire on musical education and appreciation and a personal interview after the statistics had been collected.

Illuminating Engineering—A New Profession: ARTHUR H. FORD.

Some Remarks on the Solubility of Certain Salts in Water: LEROY D. WELD.

Notes on the Pollination and Variation of Red Clover (Trifolium pratense): L. H. PAMMEL and CHARLOTTE M. KING.

Giving notes on the more important insects that pollinate the red clover in the state of Iowa and their relation to fertility; compares the amount of seeds produced per head and the number of flowers, showing an extreme variation.

The Ecology of a Prairie Formation with Adjacent Swamp and Woodland in Story County, Iowa: ADA HAYDEN.

Gives a physiographic account of the region with a physical analysis of the soil and the temperature records for an entire growing season and a list of plants found on each formation and the repopulation of tillable soil which is reverting to prairie.

Some Notes on Iowa Fungi: T. H. MACBRIDE.

The Flowers of Myriophyllum spicatum: N. D. KNUPP.

Glaciated Rock Surfaces near Linn and at Quarry: W. H. NORTON.

Some Features of the Bering River Coal Field, Alaska: GEORGE F. KAY.

Problems on the Border Lines between Geology and the other Sciences: GEORGE F. KAY.

In this paper attention is called to the need of cooperative work among investigators in the different fields of science. Reference is made to several bulletins and papers which have already been published by the chemists of the United States Geological Survey, by the physicists of the geophysical laboratory, and by other scientists, throwing light on many problems in geology which heretofore were obscure. The necessity for further work upon border problems, already under investigation, and upon many other problems which need solution, is emphasized.

Graphics of Ore Origin: CHARLES R. KEYES.

In calling attention to some of the newest aspects of ore genesis charts were prepared showing (1) the old conceptions of the origin of ore deposits, (2) the later ideas of secondary sulphide enrichment and (3) the latest views concerning the genesis of ore deposits generally. The last mentioned is presented as a rational scheme for a genetic classification of ore deposits.

Depositional Phases of Eolation under the Stimulus of Aridity: CHARLES R. KEYES.

It is now a question whether wind-scour under the stimulus of a typically arid climate is not actually the most potent and persistent of all erosive agencies. Under favorable conditions its general efficiency must greatly exceed that of stream-action in normally moist lands. At any rate, erosionally, its world's work is probably surpassed neither by that of hydrasion nor by that of glaciation.

Volcanic Phenomena of Coon Butte Region, Arizona: CHARLES R. KEYES.

Contrary to the recently expressed views regarding the origin of this remarkable crater, the most critical evidences seem to indicate that this feature of the local landscape is only one of the many manifestations of the explosive type of vulcanism so prevalent throughout the region.

Some Characteristics of Light-negative Selenium: Miss LILAH B. CRUM.

The Use of a Ballistic Galvanometer and a Pendulum for Measuring rapidly Fluctuating Resistances: WM. H. CLARK.

Many methods for measuring constant resistances are employed. The method here described is one that we have used in the physical laboratory at the State University of Iowa to measure a fluctuating resistance. The apparatus consists of a pendulum, a Wheatstone bridge mesh including a battery of small E.M.F., and a galvanometer. The unknown resistance in the fourth arm of the bridge in this particular case happened to be a selenium cell. The pendulum was about thirty inches in length and swung through an arc of twenty-eight inches. The arc over which it swung was graduated with respect to time, the smallest division being .00125 sec. The period of vibration was .6 sec. Four keys adjusted to open and close two electrical circuits were placed on the arc over which the pendulum swung. The operation of the first two keys illuminated the selenium cell, the second two keys operated the galvanometer circuit. The length of time that either circuit was closed was determined by the distance between the two keys which opened and closed that circuit. Keys k_1 and k_2 which operated the lighting circuit were placed a given distance apart corresponding to the desired length of exposure of the cell to light. Then keys k_3 and k_4 were placed apart a constant distance equal to .05 sec. If the change of resistance is called Δx and the length of exposure to light is called Δt, then $\Delta x = cd/\Delta t$ where d is the deflection and c is the galvanometer constant. This equation is used for small resistances. When Δx becomes comparable to x another device is employed. Since Δx is a function of the deflection we replace the unknown fluctuating resistance by a known variable resistance and, keeping the ratio arms of the bridge the same, vary the resistance to secure deflections covering the same range of scale. A curve between change of resistance and deflection is plotted. Then for any deflection caused by the fluctuation of the unknown resistance we can at once read from this curve the corresponding change of resistance. The method is probably as accurate and as easy to manipulate as any method that has been devised for measuring rapidly fluctuating resistances.

The Nature of Light-action in Selenium: F. C. BROWN.

The Doppler Effect in Electrodeless Discharge: FRANK F. ALMY.

Some Laboratory Apparatus in Elementary Physical Measurements: FRANK F. ALMY.

The Action of Epinephrin upon the Muscle Tissue of the Vein: JOHN MCCLINTOCK.

A Method for Studying Embryos as Related to Medical Work: H. J. PRENTISS.

The Peripheral Distribution of Cranial Nerves in Necturus maculatus: H. W. NORRIS and MARGARET BUCKLEY.

The Zoological Rank of Necturus as Indicated by the Origin and Distribution of its Cranial Nerves: H. W. NORRIS.

Notes on Methods for the Study of Amphibian Eggs and Larvæ: ALBERT KUNTZ.

The Development of Lymph Channels in Turtles by the Fusion of Mesenchymal Spaces: FRANK A. STROMSTEN.

1. The theory that the lymphatic system is budded off from the venous system is a direct product of a special method of investigation, *i. e.*, the injection method.

2. The injection method alone is entirely unreliable, because: (*a*) Only that portion of the lymphatic system which is in direct connection with the point of injection (lymph sacs) is shown, the unconnected spaces are not indicated. (*b*) Extravasations and venous injections vitiate the results.

3. Serial sections, both injected and uninjected, of turtle embryos of different ages show the successive stages of the development of lymphatics from the spongy mesenchyme surrounding the aorta and larger arteries, through the formation of independent spaces which constantly enlarge and finally fuse to form continuous channels.

4. The endothelium of the lymphatics arises entirely independent of the venous endothelium from the original mesenchymal cells.

Some Notes on Iowa Reptiles: M. P. SOMES.

Building a Museum: T. VAN HYNING.

An outline plan of building an Iowa state museum; showing the approximate amount of museum material in the state required for a museum, together with showing the number of cases required, case space, floor space, etc., for a completed museum representative of the state. A cooperative plan of school museums, whereby the schools of the state may cooperate with the state museum in supplying a museum for all of the schools is proposed.

Notes on the Black-Crowned Heron: B. H. BAILEY.

The College Museum: B. H. BAILEY.

(Abstracts furnished by the authors.)

Eighty-eight new names were added to the roll of membership. The meeting of 1912 will be held at the State Historical Building in Des Moines, and will be a meeting celebrating the twenty-fifth anniversary of the organization of the academy.

Officers elected for the ensuing year are:

President—Louis Begeman, Cedar Falls.

First Vice-president—A. A. Bennett, Ames.

Second Vice-president—C. N. Kinney, Des Moines.

Secretary—L. S. Ross, Des Moines.

Treasurer—G. F. Kay, Iowa City.

Members of the Executive Committee—H. S. Conard, Grinnell; B. H. Bailey, Cedar Rapids; H. M. Kelley, Mt. Vernon.

L. S. ROSS,
Secretary

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 696th meeting was held on May 20, 1911, Vice-president Fischer in the chair. Three papers were read.

Experiments with Different Types of Voltameters: Mr. G. W. VINAL, of the Bureau of Standards.

According to Faraday's law for electrolytes the deposits of silver in different types of voltameters should be equal when the same number of coulombs of electricity has passed through each, provided, however, that there are no secondary reactions taking place. Differences in weight and appearance have been observed, particularly between the porous cup and filter paper forms. We have endeavored to find an explanation of these effects and to push the accuracy of our measurements beyond the limits hitherto attained. A constant temperature balance room has obviated the difficulties usually encountered in weighing the platinum bowls. The current has been measured by balancing the potential drop across a standard resistance against the voltage of a Weston cell and also by the potentiometer method. The purity of the electrolyte is of great importance and the tests will be discussed elsewhere.

The Kohlrausch, or no septum form as we have used it, consists of a glass dish under the anode and a ring of glass in the surface of the liquid to prevent the slime formed during electrolysis from reaching the cathode.

The siphon voltameter is unsatisfactory even when short siphons of large diameters are used, owing to the heating and large volume of electrolyte which may yield erroneous results if the electrolyte is not quite pure.

The filter paper form devised by Lord Rayleigh employs a sheet of filter paper to separate the anode and cathode. We have found the deposits in it abnormally heavy and striated in appearance, which effects are due to the filter paper not being chemically inert. Striated deposits are always heavy. We have studied the cause for striations and find two conditions to be necessary and sufficient for their production, viz., (1) the presence of reducing impurities in the electrolyte, (2) the motion of the liquid over the face of the cathode. When both of these conditions are fulfilled we may suppose any given initial distribution of points of silver which will grow in the direction of the liquid currents (usually vertical) since the crystalline structure is destroyed by colloidal deposits. In this way a crystal grows into the one above it and eventually a striation is formed. The initial spacing of the crystals and consequently the spacing of the striations is dependent on the current density.

T. W. Richards has advocated the use of a porous cup instead of filter paper to more perfectly separate the anode and cathode liquids. He gave as a reason for this substitution that a heavy complex ion could pass through the filter paper and increase the weight of deposit, but we have found that by using two or three thicknesses of filter paper the effect instead of being diminished is materially increased. The evidence of our work does not support the complex ion theory.

We have used two sizes of porous cup voltameters and find that with electrolytes, a trifle impure, that the larger will give the heavier deposit. This phenomenon we have called the "volume effect." It is a severe test of the purity of the electrolyte. With pure electrolytes the deposits in this form are always crystalline and free from striations. The efficiency of the porous cup as a separator of the anode and cathode liquids is shown by the fact that an impure solution may be placed inside the porous cup without affecting the deposit outside or if the deposit from a contaminated solution be compared with the deposit from the same solution after filtering through a porous cup it will be noted that the striations have disappeared from the deposit.

The small porous cup voltameter possesses many advantages over the other forms. We find from a long series of determinations two identical voltameters of this type will agree to within one part in 100,000.

The London Conference of 1908 has declared that the electro-chemical equivalent of silver is 1.11800 mg. per coulomb, and, therefore, using this value and the international ohm and the second we find the voltage of the Weston normal cell at 20° C. to be

1.01827 volts, $\pm$ .00003.

The Chemistry of the Silver Voltameter: Dr. A. S. McDaniel, of the Bureau of Standards.

The first problem in the chemical investigation of the voltameter was an investigation of the filter paper septum. This led to the detection of the classes of impurities in the voltameter. The plan of investigation of the filter paper form of voltameter was outlined. In this connection Smith's work at the National Physical Laboratory was mentioned. He added substances to the electrolyte to produce the observed striations in the deposits, and hence concluded that the striations were due to the impurities of the electrolyte. The speaker had also produced the striations experimentally. Tests were also made by the speaker to test the effect of the filter paper upon the striations. The striations produced by certain substances added to the electrolyte were described and illustrated by lantern slides.

Experiments were tried of extracting the impurities from the filter papers by soaking them in water and then drying them in the voltameter, but it was found that the striations were still produced. It was concluded from this that oxicellulose (oxidized filter paper) caused the active principle of the striations. The degree of acidity or alkalinity has quite an effect in determining the direction of travel of the colloidal deposit or particles.

Tests were also made to account for the increase in weight of the colloidal deposit on the cathode. The effect of silk and porous pot septa in voltameters was also investigated. The treatment of the pot before use to make it sufficiently resistant, and the action of the pot on the silver nitrate, were briefly stated.

The preparation of liquids for use in the voltameter were described, and mention was made of the determination of the electro-chemical equivalent of silver nitrate.

The Silver Voltameter as an International Electrical Standard: Dr. E. B. Rosa, of the Bureau of Standards.

The silver voltameter has been used as the official standard for the measurement of electric current since the International Electrical Congress which met in Chicago in 1893. The definitions and specifications for the fundamental electrical units recommended by the Chicago congress were adopted by the United States and several other countries in 1894. Germany, however, did not act in the matter until 1898 and then adopted somewhat different definitions and a different numerical value for the Clark standard cell which resulted in a different value of the volt. Austria and some other countries followed the example of Germany, so that for the last twelve years the ampere and volt have been slightly different in one group of countries from its value in the other countries. The International Congress at London in 1908 came to an agreement on the definitions such that there might be international uniformity, but could not fix upon the value of the standard cell for want of complete specifications of the silver voltameter and also for want of agreement among different experimenters with the silver voltameter. It was for the purpose of clearing up some of the mysteries in connection with this instrument, which has been the subject of more than forty scientific papers by investigators in several different countries during the last thirty years, that the work was taken up at the Bureau of Standards three years ago and has been carried on continuously ever since. One year ago an international committee representing four of the national standards laboratories met in Washington and carried out a series of investigations at the Bureau of Standards chiefly upon the silver voltameter. As a result of these investigations a new value for the Weston cell was agreed upon after recommendation to the International Committee on Electrical Units and Standards and that value has since been adopted, so that we now have in America the same value for the volt and ampere as is used in the principal countries of the world; this value will, undoubtedly, soon become universal. There still remain some outstanding questions in connection with the silver voltameter which must be solved before complete specifications can be agreed upon, but the investigations at the Bureau of Standards and elsewhere during the last two or three years have cleared up many of the questions which were outstanding at the time of the London conference in 1908.

(The first and last of the above abstracts are by the authors of the papers.)

R. L. Faris,
Secretary

SCIENCE

FRIDAY, JULY 14, 1911

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

JAMES AS A PHILOSOPHER[1]

FIFTY years since, if competent judges were asked to name the American thinkers from whom there had come novel and notable and typical contributions to general philosophy, they could in reply mention only two men—Jonathan Edwards and Ralph Waldo Emerson. For the conditions that determine a fair answer to the question, "Who are your representative American philosophers?" are obvious. The philosopher who can fitly represent the contribution of his nation to the world's treasury of philosophical ideas, must first be one who thinks for himself, fruitfully, with true independence, and with successful inventiveness, about problems of philosophy. And, secondly, he must be a man who gives utterance to philosophical ideas which are characteristic of some stage and of some aspect of the spiritual life of his own people. In Edwards and in Emerson, and only in these men, had these two conditions found their fulfilment, so far as our American civilization had yet expressed itself in the years that had preceded our civil war. Edwards, in his day, made articulate some of the great interests that had moulded our early religious life. The thoughts which he most discussed were indeed, in a sense, old, since they largely concerned a traditional theology. Yet both in theology and general philosophy, Edwards was an originator. For he actually rediscovered some of the world's profoundest ideas

[1] Oration delivered on June 29 at the annual exercises of the Harvard Chapter of Phi Beta Kappa.

regarding God and humanity simply by reading for himself the meaning of his own religious experience. With a mysterious power of philosophical intuition, even in his early youth, he observed what, upon the basis of what we know to have been his range of philosophical reading, we could not possibly have expected him to observe. If the sectarian theological creed that he defended was to our minds narrow, what he himself saw was very far-reaching and profound. For he viewed religious problems with synoptic vision that enabled him to reconcile, in his own personal way, some of the greatest and most tragic conflicts of the spiritual world, and what he had to say consequently far transcended the interests of the special theological issues which he discussed. Meanwhile, he spoke not merely as a thinker, but as one who gave voice to some of the central motives and interests of our colonial religious life. Therefore he was, in order of time the first of our nationally representative philosophers.

Another stage of our civilization—a later phase of our national ideals—found its representative in Emerson. He too was in close touch with many of the world's deepest thoughts concerning ultimate problems. Some of the ideas that most influenced him have their far-off historical origins in oriental as well as in Greek thought, and also their nearer foreign sources in modern European philosophy. But he transformed whatever he assimilated. He invented upon the basis of his personal experience, and so he was himself no disciple of the orient, or of Greece, still less of England and of Germany. He thought, felt and spoke as an American.

Fifty years ago, I say, our nation had so far found these two men to express each his own stage of the philosophy of our national civilization. The essence of a philosophy, in case you look at it solely from a historical point of view, always appears to you thus: A great philosophy expresses an interpretation of the life of man and a view of the universe, which is at once personal, and if the thinker is representative of his people, national in its significance. Edwards and Emerson had given tongue to the meaning of two different stages of our American culture. And these were thus far our only philosophical voices.

To-day, if we ask any competent foreign critic of our philosophy whether there is any other name to be added to these two classic American philosophers, we shall receive the unanimous answer: "There is to-day a third representative American philosopher. His name is William James." For James meets the two conditions just mentioned. He has thought for himself, fruitfully, with true independence, and with successful inventiveness. And he has given utterance to ideas which are characteristic of a stage and of an aspect of the spiritual life of this people. He, too, has been widely and deeply affected by the history of thought. But he has reinterpreted all these historical influences in his own personal way. He has transformed whatever he has assimilated. He has rediscovered whatever he has received from without; because he never could teach what he had not himself experienced. And, in addition, he has indeed invented effectively and richly. Moreover, in him certain characteristic aspects of our national civilization have found their voice. He is thus the third in the order of time among our representative American philosophers. Already, within a year of his death, he has begun to acquire something of a classic rank and dignity. In future this rank and dignity will long increase. In one of

James's latest utterances he indeed expressed, with characteristic energy, a certain abhorrence of what he called classical tendencies in philosophical thought. But I must repeat the word: Fortune not unjustly replies, and will reply to James's vigorous protest against every form of classicism, by making him a classic.

Thus, then, from the point of view of the competent foreign students of our philosophy, the representative American philosophers are now three and only three —Edwards, Emerson, James.

And of these three there can be little question that, at the present time, the most widely known abroad is James. Emerson has indeed found a secure place in the minds of the English-speaking lovers of his type of thought everywhere; and has had an important part in the growth of some modern German tendencies. But James has already won, in the minds of French, of German, of Italian, and of still other groups of foreign readers, a position which gives him a much more extended range of present influence than Emerson has ever possessed.

It is my purpose, upon the present occasion, to make a few comments upon the significance of William James's philosophy. This is no place for the discussion of technical matters. Least of all have I any wish to undertake to decide, upon this occasion, any controversial issues. My intentions as I address you are determined by very simple and obvious considerations. William James was my friend from my youth to the end of his beneficent life. I was once for a brief time his pupil. I long loved to think of myself as his disciple; although perhaps I was always a very bad disciple. But now he has just left us. And as I address you I remember that he was your friend also. Since the last annual meeting of this assembly he has been lost to us all. It is fitting that we should recall his memory to-day. Of personal reminiscences, of biographical sketches, and of discussions relating to many details of his philosophy, the literature that has gathered about his name during the few months since we lost him, has been very full. But just as this is no occasion for technical discussion of his philosophy so too I think this is no place to add new items to the literature of purely personal reminiscence and estimate of James. What I shall try to do is this: I have said that James is an American philosopher of classic rank, because he stands for a stage in our national self-consciousness—for a stage with which historians of our national mind must always reckon. This statement, if you will permit, shall be my text. I shall devote myself to expounding this text as well as I can in my brief time, and to estimating the significance of the stage in question, and of James's thought in so far as it seems to me to express the ideas and the ideals characteristic of this phase of our national life.

I

In defining the historical position which William James, as a thinker, occupies, we have of course to take account, not only of national tendencies, but also of the general interests of the world's thought in his time. William James began his work as a philosopher, during the seventies of the last century, in years which were, for our present purpose, characterized by two notable movements of world-wide significance. These two movements were at once scientific in the more special sense of that term, and philosophical in the broad meaning of that word. The first of the movements was concerned with the elaboration—the widening and the deepening of the newer doctrines about evolution. This movement

had indeed been preceded by another. The recent forms of evolutionary doctrine, those associated with the names of Darwin and of Spencer, had begun rapidly to come into prominence about 1860. And the decade from 1860 to 1870, taken together with the opening years of the next decade, had constituted what you may call the storm and stress period of Darwinism, and of its allied tendencies, such as those which Spencer represented. In those years the younger defenders of the new doctrines so far as they appealed to the general public, fought their battles, declared their faith, out of weakness were made strong and put to flight the armies of the theologians. You might name, as a closing event of that storm and stress period, Tyndall's famous Belfast address of 1874, and the warfare waged about that address. Haeckel's early works, some of Huxley's most noted polemic essays, Lange's "History of Materialism," the first eight or nine editions of Von Hartmann's "Philosophy of the Unconscious," are documents characteristic of the more general philosophical interests of that time. In our country, Fiske's "Cosmic Philosophy" reflected some of the notable features that belonged to these years of the early conquests of evolutionary opinion.

Now in that storm and stress period, James had not yet been before the public. But his published philosophical work began with the outset of the second and more important period of evolutionary thought—the period of the widening and deepening of the new ideas. The leaders of thought who are characteristic of this second period no longer spend their best efforts in polemic in favor of the main ideas of the newer forms of the doctrine of evolution. In certain of its main outlines—outlines now extremely familiar to the public—they simply accept the notion of the natural origin of organic forms and of the general continuity of the processes of development. But they are concerned, more and more, as time goes on, with the deeper meaning of evolution, with the study of its factors, with the application of the new ideas to more and more fields of inquiry, and, in case they are philosophers, with the reinterpretation of philosophical traditions in the light of what had resulted from that time of storm and stress.

James belongs to this great second stage of the evolutionary movement, to the movement of the elaboration, of the widening and deepening of evolutionary thought, as opposed to that early period of the storm and stress. We still live in this second stage of evolutionary movement. James is one of its most inventive philosophical representatives. He hardly ever took part in the polemic in favor of the general evolutionary ideas. Accepting them, he undertook to interpret and apply them.

And now, secondly, the period of James's activity is the period of the rise of the new psychology. The new psychology has stood for many other interests besides those of a technical study of the special sciences of the human and of the animal mind. What is technical about psychology is indeed important enough. But the special scientific study of mind by the modern methods used in such study has been a phase and a symptom of a very much larger movement—a movement closely connected with all that is most vital in recent civilization, with all the modern forms of nationalism, of internationalism, of socialism, and of individualism. Human life has been complicated by so many new personal and social problems, that man has needed to aim, by whatever means are possible, towards a much more

elaborate knowledge of his fellow-man than was ever possible before. The results of this disposition appear in the most widely diverse sciences and arts. Archeology and ethnology, history and the various social sciences, dramatic art, the novel, as well as what has been called psychical research —in a word, all means, good and bad, that have promised either a better knowledge of what man is or a better way of portraying what knowledge of man one may possess—have been tried and moulded in recent times by the spirit of which recent technical psychology is also an expression. The psychological movement means then something that far transcends the interests of the group of sciences to which the name psychology now applies. And this movement assumed some of its most important recent forms during the decade in which James began to publish his work. His own contributions to psychology reflect something of the manifoldness and of the breadth of the general psychological movement itself. If he published the two great volumes entitled "Psychology" he also wrote "The Varieties of Religious Experience," and he played his part in what is called "psychical research."

These then are James's two principal offices when you consider him merely in his most general relations to the thought of the world at large in his time. He helped in the work of elaborating and interpreting evolutionary thought. He took a commanding part in the psychological movement.

II

But now it is not of these aspects of James's work, significant as they are, that I have here especially to speak. I must indeed thus name and emphasize these wider relations of his thought to the world's contemporary thought. But I do so in order to give the fitting frame to our picture. I now have to call attention to the features about James which make him, with all his universality of interest, a representative American thinker. Viewed as an American, he belongs to the movement which has been the consequence first, of our civil war, and secondly, of the recent expansion, enrichment, and entanglement of our social life. He belongs to the age in which our nation, rapidly transformed by the occupation of new territory, by economic growth, by immigration and by education, has been attempting to find itself anew, to redefine its ideals, to retain its moral integrity, and yet to become a world power. In this stage of our national consciousness we still live and shall plainly have to live for a long time in the future. The problems involved in such a civilization we none of us well understand; least of all do I myself understand them. And James, scholar, thinker, teacher, scientific and philosophical writer as he was, has of course only such relation to our national movement as is implied by the office that he thus fulfills. Although he followed with keen interest a great variety of political and social controversies, he avoided public life. Hence he was not absorbed by the world of affairs, although he was always ready to engage generously in the discussion of practical reforms. His main office with regard to such matters was therefore that of philosophical interpreter. He helped to enlighten his fellows as to the relations between the practical problems of our civilization and those two world-wide movements of thought of which I have just spoken.

Let me call attention to some of the results of James's work as interpreter of the problems of the American people. I need not say that this work was, to his own mind, mainly incidental to his interest in

those problems of evolutionary thought and of psychology to which I just directed your attention. I am sure that James himself was very little conscious that he was indeed an especially representative American philosopher. He certainly had no ambition to vaunt himself as such. He worked with a beautiful and hearty sincerity upon the problems that as a fact interested him. He knew that he loved these problems because of their intense human interest. He knew, then, that he was indeed laboring in the service of mankind. But he so loved what he called the concrete, the particular, the individual, that he naturally made little attempt to define his office in terms of any social organism, or of any such object as our national life, viewed as an entity. And he especially disliked to talk of causes in the abstract, or of social movements as I am here characterizing them. His world seemed to him to be made up of individuals—men, events, experiences and deeds. And he always very little knew how important he himself was, or what vast inarticulate social forces were finding in him their voice. But we are now viewing James from without, in a way that is of course as imperfect as it is inevitable. We therefore have a right at this point to attribute to him an office that, as I believe, he never attributed to himself.

And here we have to speak first of James's treatment of religious problems, and then of his attitude towards ethics.

Our nation since the civil war has largely lost touch with the older forms of its own religious life. It has been seeking for new embodiments of the religious consciousness, for creeds that shall not be in conflict with the modern man's view of life. It was James's office, as psychologist, and as philosopher, to give a novel expression to this our own national variety of the spirit of religious unrest. And his volume "The Varieties of Religious Experience," is one that, indeed, with all its wealth of illustration, and in its courageous enterprise, has a certain classic beauty. Some men preach new ways of salvation. James simply portrayed the meaning that the old ways of salvation had possessed, or still do possess, in the inner and personal experience of those individuals whom he has called the religious geniuses. And then he undertook to suggest an hypothesis as to what the whole religious process might mean. The hypothesis is on the one hand in touch with certain tendencies of recent psychology. And in so far it seems in harmony with the modern consciousness. On the other hand it expresses, in a way, James's whole philosophy of life. And in this respect it comes into touch with all the central problems of humanity.

The result of this portrayal was indeed magical. The psychologists were aided towards a new tolerance in their study of religion. The evolution of religion appeared in a new light. And meanwhile many of the faithful, who had long been disheartened by the later forms of evolutionary naturalism, took heart anew when they read James's vigorous appeal to the religious experience of the individual as to the most authoritative evidence for religion. "The most modern of thinkers, the evolutionist, the psychologist," they said, "the heir of all the ages, has thus vindicated anew the witness of the spirit in the heart—the very source of inspiration in which we ourselves have always believed." And such readers went away rejoicing, and some of them even began to write christologies based upon the doctrine of James as they understood it. The new gospel, the glad tidings of the subconscious, began to be preached in many

lands. It has even received the signal honor of an official papal condemnation.

For my own part, I have ventured to say elsewhere that the new doctrine, viewed in one aspect, seems to leave religion in the comparatively trivial position of a play with whimsical powers—a prey to endless psychological caprices. But James's own robust faith was that the very caprices of the spirit are the opportunity for the building-up of the highest forms of the spiritual life; that the unconventional and the individual in religious experience are the means whereby the truth of a superhuman world may become most manifest. And this robust faith of James, I say, whatever you may think of its merits, is as American in type as it has already proved effective in the expression which James gave to it. It is the spirit of the frontiersman, of the gold seeker, or the home builder, transferred to the metaphysical and to the religious realm. There is our far-off home, our long-lost spiritual fortune. Experience alone can guide us towards the place where these things are; hence you indeed need experience. You can only win your way on the frontier in case you are willing to live there. Be, therefore, concrete, be fearless, be experimental. But, above all, let not your abstract conceptions, even if you call them scientific conceptions, pretend to set any limits to the richness of spiritual grace, to the glories of spiritual possession, that, in case you are duly favored, your personal experience may reveal to you. James reckons that the tribulations with which abstract scientific theories have beset our present age are not to be compared with the glory that perchance shall be, if only we open our eyes to what experience itself has to reveal to us.

In the quest for the witness to whom James appeals when he tests his religious doctrine, he indeed searches the most varied literature; and of course most of the records that he consults belong to foreign lands. But the book called "The Varieties of Religious Experience" is full of the spirt that, in our country, has long been effective in the formation of new religious sects; and this volume expresses, better than any sectarian could express, the recent efforts of this spirit to come to an understanding with modern naturalism, and with the new psychology. James's view of religious experience is meanwhile at once deliberately unconventional and intensely democratic. The old world types of reverence for the external forms of the church find no place in his pages; but equally foreign to his mind is that barren hostility of the typical European free thinkers for the church with whose traditions they have broken. In James's eyes, the forms, the external organizations of the religious world simply wither; it is the individual that is more and more. And James, with a democratic contempt for social appearances, seeks his religious geniuses everywhere. World-renowned saints of the historic church receive his hearty sympathy; but they stand upon an equal footing, in his esteem, with many an obscure and ignorant revivalist, with faith healers, with poets, with sages, with heretics, with men that wander about in all sorts of sheepskins and goatskins, with chance correspondents of his own, with whomsoever you will of whom the world was not and is not worthy, but who, by inner experience, have obtained the substance of things hoped for, the evidence of things not seen.

You see, of course, that I do not believe James's resulting philosophy of religion to be adequate. For as it stands it is indeed chaotic. But I am sure that it can only be amended by taking it up into a larger view,

and not by rejecting it. The spirit triumphs, not by destroying the chaos that James describes, but by brooding upon the face of the deep until the light comes, and with light, order. But I am sure also that we shall always have to reckon with James's view. And I am sure also that only an American thinker could have written this survey, with all its unconventional ardor of appreciation, with all its democratic catholicity of sympathy, with all its freedom both from ecclesiastical formality and from barren free thinking. I am sure also that no book has better expressed the whole spirit of hopeful unrest, of eagerness to be just to the modern view of life, of longing for new experience, which characterizes the recent American religious movement. In James's book then the deeper spirit of our national religious life has found its most manifold and characteristic expression.

III

I must next turn to the other of the two aspects of James's work as a thinker that I mentioned above, namely to his ethical influence. Since the war our transformed and restless people has been seeking not only for religious, but for moral guidance. What are the principles that can show us the course to follow in the often pathless wilderness of the new democracy? It frequently seems as if, in every crisis of our greater social affairs we needed somebody to tell us both our dream and the interpretation thereof. We are eager to have life, and that abundantly. But what life? And by what test shall we know the way of life?

The ethical maxims that most readily meet the popular demand for guidance in such a country, and at such a time, are maxims that combine attractive vagueness with an equally winning pungency. They must seem obviously practical; but must not appear excessively rigorous. They must arouse a large enthusiasm for action, without baffling us with the sense of restraint, or of wearisome self-control. They must not call for extended reflection. Despite their vagueness they must not appear abstract, nor yet hard to grasp. The wayfaring man, though a fool, must be sure that he at least will not err in applying our moral law. Moral blunders must be natural only to opponents, not to ourselves. We must be self-confident. Moreover, our moral law must have an athletic sound. Its first office is to make us "good sports." Only upon such a law can we meditate day and night, in case the "game" leaves us indeed any time for meditation at all. Nevertheless, these popular maxims will of course not be meant as mere expressions of blind impulse. On the contrary, they will appeal to highly intelligent minds, but to minds anxious for relief from the responsibility of being too thoughtful. In order to be easily popular they must be maxims that stir the heart, not precisely indeed like the sound of a trumpet, but more like the call of the horn of an automobile. You will have in mind the watchwords that express some of the popular ethical counsels thus suggested. One of these watchwords has of late enabled us to abbreviate a well-known and surely a highly intelligent maxim, to something that is to-day used almost as a mere injection. It is the watchword, "Efficiency"! Another expression of the same motive takes shape in the equally familiar advice, "Play the game."

Now I do not mean to make light of the real significance of just such moral maxims, for awakening and inspiring just our people in this day. The true value of these maxims lies for us in three of their characteristic features. First, they give us counsel that is in any case opposed

to sloth. And sloth on every level of our development remains one of the most treacherous and mortal enemies of the moral will. Secondly, they teach us to avoid the dangers to which the souls of Hamlet's type fall a prey. That is, they discourage the spirit that reflectively divides the inner self, and that leaves it divided. They warn us that the divided self is indeed, unless it can heal its deadly wound, by fitting action, a lost soul. And thirdly, they emphasize courage. And courage—not, to be sure, so much the courage that faces one's rivals in the market place, or one's foes on the battlefield as the courage that fits us to meet our true spiritual enemies—the courage that arises anew from despair and that undertakes, despite all tribulations, to overcome the world—such courage is one of the central treasures of the moral life.

Because of these three features, the maxims to which I refer are in all their vagueness, vehicles of wisdom. But they express themselves in their most popular forms with a wilfulness that is often more or less comic, and that is sometimes tragic. For what they do not emphasize is the significance of self-possession, of lifting up our eyes to the hills whence cometh our help, of testing the life that now is by the vision of the largest life that we can in ideal appreciate. These popular maxims also emphasize results rather than ideals, strength rather than cultivation, temporary success rather than wholeness of life, the greatness of "Him that taketh a city," rather than of "Him that ruleth his spirit." They are the maxims of unrest, of impatience and of a certain humane and generous unscrupulousness, as fascinating as it is dangerous. They characterize a people that is indeed earnestly determined to find itself, but that so far has not found itself.

Now one of the most momentous problems regarding the influence of James is presented by the question: How did he stand related to these recent ethical tendencies of our nation? I may say at once that, in my opinion, he has just here proved himself to be most of all and in the best sense our national philosopher. For the philosopher must not be an echo. He must interpret. He must know us better than we know ourselves, and this is what indeed James has done for our American moral consciousness. For, first, while he indeed made very little of the formal office of an ethical teacher and seldom wrote upon technical ethical controversies, he was, as a fact, profoundly ethical in his whole influence. And next, he fully understood, yes shared in a rich measure, the motives to which the ethical maxims just summarized have given expression. Was not he himself restlessly active in his whole temperament? Did he not love individual enterprise and its free expression? Did he not loathe what seemed to him abstractions? Did he not insist that the moralist must be in close touch with concrete life? As psychologist did he not emphasize the fact that the very essence of conscious life lies in its active, yes, in its creative relation to experience? Did he not counsel the strenuous attitude towards our tasks? And are not all these features in harmony with the spirit from which the athletic type of morality just sketched seems to have sprung?

Not only is all this true of James, but, in the popular opinion of the moment, the doctrine called pragmatism, as he expounded it in his Lowell lectures, seems, to many of his foreign critics, and to some of those who think themselves his best followers here at home, a doctrine primarily ethical in its force, while, to some minds, pragmatism seems also to be a sort of phi-

losophical generalization of the efficiency doctrine just mentioned. To be sure, any closer reader of James's "Pragmatism" ought to see that his true interests in the philosophy of life are far deeper than those which the maxims "Be efficient," and, "Play the game" mostly emphasize. And, for the rest, the book on pragmatism is explicitly the portrayal of a method of philosophical inquiry, and is only incidentally a discourse upon ethically interesting matters. James himself used to protest vigorously against the readers who ventured to require of the pragmatist viewed simply as such, any one ethical doctrine whatever. In his book on "Pragmatism" he had expounded, as he often said, a method of philosophizing, a definition of truth, a criterion for interpreting and testing theories. He was not there concerned with ethics. A pragmatist was free to decide moral issues as he chose, so long as he used the pragmatic method in doing so, that is, so long as he tested ethical doctrines by their concrete results, when they were applied to life.

Inevitably, however, the pragmatic doctrine that both the meaning and the truth of ideas shall be tested by their empirical consequences of these ideas and by the practical results of acting them out in life, has seemed both to many of James's original hearers, and to some of the foreign critics just mentioned, a doctrine that is simply a characteristic Americanism in philosophy—a tendency to judge all ideals by their practical efficiency, by their visible results, by their so-called "cash values."

James, as I have said, earnestly protested against this cruder interpretation of his teaching. The author of "The Varieties of Religious Experience" and of the "Pluralistic Universe" was indeed an empiricist, a lover of the concrete and a man who looked forward to the future rather than backward to the past; but despite his own use, in his "Pragmatism" of the famous metaphor of the "cash values" of ideas, he was certainly not a thinker who had set his affections upon things below rather than upon things above. And the "consequences" upon which he laid stress when he talked of the pragmatic test for ideas, were certainly not the merely worldly consequences of such ideas in the usual sense of the word "worldly." He appealed always to experience; but then for him, experience might be, and sometimes was, religious experience—experience of the unseen and of the superhuman. And so James was right in his protest against these critics of his later doctrine. His form of pragmatism was indeed a form of Americanism in philosophy. And he too had his fondness for what he regarded as efficiency, and for those who "play the game," whenever the game was one that he honored. But he also loved too much those who are weak in the eyes of this present world—the religious geniuses, the unpopular inquirers, the noble outcasts. He loved them, I say, too much to be the dupe of the cruder forms of our now popular efficiency doctrine. In order to win James's most enthusiastic support, ideas and men needed to express an intense inner experience along with a certain unpopularity which showed that they deserved sympathy. Too much worldly success, on the part of men or of ideas, easily alienated him. Unworldliness was one of the surest marks, in his eyes, of spiritual power, if only such unworldliness seemed to him to be joined with interests that, using his favorite words, he could call "concrete" and "important."

In the light of such facts, all that he said about judging ideas by their "consequences" must be interpreted, and there-

fore it is indeed unjust to confound pragmatism with the cruder worship of efficiency.

IV

Yet, I repeat, James's philosophy of life was indeed, in its ethical aspects, an expression of the better spirit of our people. He understood, he shared, and he also transcended the American spirit. And just that is what most marks him as our national philosopher. If you want to estimate his philosophy of life in its best form, you must read or re-read, not the "Pragmatism," but the essays contained in the volume entitled "The Will to Believe."

May I still venture, as I close, to mention a few features of the doctrine that is embodied in that volume? The main question repeatedly considered in these essays of James is explicitly the question of an empiricist, of a man averse to abstractions, and of an essentially democratic thinker, who does not believe that any final formulation of an ideal of human life is possible until the last man has had his experience of life, and has uttered his word. But this empiricism of the author is meanwhile the empiricism of one who especially emphasizes the central importance of the active life as the basis of our interpretation of experience. Herein James differs from all traditional positivists. Experience is never yours merely as it comes to you. Facts are never mere data. They are data to which you respond. Your experience is constantly transformed by your deeds. That this should be the case is determined by the most essential characteristics of your consciousness. James asserts this latter thesis as psychologist, and has behind him, as he writes, the vast mass of evidence that his two psychological volumes present. The simplest perception, the most elaborate scientific theory, illustrate how man never merely finds, but also always cooperates in creating his world.

No doubt then life must be estimated and guided with constant reference to experience, to consequences, to actual accomplishments, to what we Americans now call efficiency. But on the other hand efficiency itself is not to be estimated in terms of mere data. Our estimate of our world is not to be forced upon us by any mere inspection of consequences. What makes life worth living is not what you find in it, but what you are ready to put into it by your ideal interpretation of the meaning that, as you insist, it shall possess for you. This ideal meaning is always for you a matter of faith not to be imposed coercively upon another, but also never to be discovered by watching who it is that wins, or by merely feeling your present worldly strength as a player of the game. Your deeper ideals always depend upon viewing life in the light of larger unities than now appear, upon viewing yourself as a coworker with the universe for the attainment of what no present human game of action can now reveal. For this "radical empiricist" then present experience always points beyond itself to a realm that no human eye has yet seen—an empirical realm of course, but one that you have a right to interpret in terms of a faith that is itself active, but that is not merely worldly and athletic. The philosophy of action thus so imperfectly suggested by the few phrases that I have time to use, can best be interpreted, for the moment, by observing that the influence of Carlyle in many passages of this volume is as obvious as it is by our author independently reinterpreted and transformed. Imagine Carlyle transformed into a representative American thinker, trained as a naturalist, deeply versed in psychology, deprived of his disposition to hatred, open-minded towards

the interests of all sorts and conditions of men, still a hero worshiper, but one whose heroes could be found in the obscurest lovers of the ideal as easily as in the most renowned historical characters; let this transformed Carlyle preach the doctrine of the resolute spirit triumphant through creative action, defiant of every degree of mortal suffering. Let him proclaim "The Everlasting Yea" in the face of all the doubts of erring human opinion: and herewith you gain some general impression of the relations that exist between "Sartor Resartus" and "The Will to Believe."

The ethical maxims which are scattered through these pages voluntarily share much of the vagueness of our age of tentative ethical effort. But they certainly are not the maxims of an impressionist, of a romanticist, or of a partisan of merely worldly efficiency. They win their way through all such attitudes to something beyond—to a resolute interpretation of human life as an opportunity to cooperate with the superhuman and the divine. And they do this, in the author's opinion, not by destroying, but by fulfilling the purposes and methods of the sciences of experience themselves. Is not every scientific theory a conceptual reinterpretation of our fragmentary perceptions, an active reconstruction, to be tried in the service of a larger life? Is not our trust in a scientific theory itself an act of faith? Moreover, these ethical maxims are here governed, in James's exposition, by the repeated recognition of certain essentially absolute truths, truths that, despite his natural horror of absolutism, he here expounds with a finished dialectic skill that he himself, especially in his later polemic period, never seemed to prize at its full value. The need of active faith in the unseen and the superhuman he founds upon these simple and yet absolutely true principles, principles of the true dialectics of life: First, every great decision of practical life requires faith, and has irrevocable consequences, consequences that belong to the whole great world, and that therefore have endless possible importance. Secondly, since action and belief are thus inseparably bound together, our right to believe depends upon our right, as active beings, to make decisions. Thirdly, our duty to decide life's greater issues is determined by the absolute truth that, in critical cases, the will to be doubtful and not to decide, is itself a decision, and is hence no escape from our responsible moral position. And this our responsible position is a position that gives us our place in and for all future life. The world needs our deeds. We need to interpret the world in order to act. We have a right to interpret the universe so as to enable us to act at once decisively, courageously and with the sense of the inestimable preciousness and responsibility of the power to act.

In consequence of all these features of his ethical doctrine a wonderful sense of the deep seriousness and of the possibly divine significance of every deed is felt in James's every ethical counsel. Thus it is that while fully comprehending the American spirit which we have sketched, he at once expresses it and transforms it. He never loved Fichte; but there is much of the best of the ethical idealism of Fichte in "The Will to Believe." Many of you have enjoyed James's delightfully skilful polemic against Hegel, and against the external forms, phrases and appearances of the later constructive idealists. I have no wish here to attempt to comment upon that polemic; but I can assure you that I myself learned a great part of my own form of absolute idealism from the earliest expressions that James gave to the thoughts contained in "The Will to Believe." As

one of his latest works, "The Pluralistic Universe," still further showed, he himself was in spirit an ethical idealist to the core. Nor was he nearly so far in spirit even from Hegel as he supposed, guiltless as he was of Hegel's categories. Let a careful reading of the "Pluralistic Universe" make this fact manifest.

Meanwhile, what interests us is that, in "The Will to Believe," as well as in "The Pluralistic Universe," this beautifully manifold, appreciative and humane mind, at once adequately expressed, and, with true moral idealism transcended the caprices of recent American ethics. To this end he lavishly used the resources of the naturalist, of the humanist, and of the ethical dialectician. He saw the facts of human life as they are, and he resolutely lived beyond them into the realm of the spirit. He loved the concrete but he looked above towards the larger realm of universal life. He often made light of the abstract reason, but in his own plastic and active way he uttered some of the great words of the universal reason, and he has helped his people to understand and to put into practise these words.

I ask you to remember him then, not only as the great psychologist, the radical empiricist, the pragmatist, but as the interpreter of the ethical spirit of his time and of his people—the interpreter who has pointed the way beyond the trivialities which he so well understood and transcended towards that "Rule of Reason" which the prophetic maxim of our supreme court has just brought afresh to the attention of our people. That "Rule of Reason," when it comes, will not be a mere collection of abstractions. It will be, as James demanded, something concrete and practical. And it will indeed appeal to our faith as well as to our discursive logical processes. But it will express the transformed and enlightened American spirit as James already began to express it. Let him too be viewed as a prophet of the nation that is to be.

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HOWELL'S RELIEF MAPS AND THE NATURALISTIC LAND MODEL

The death of Edwin E. Howell removes one well known among those connected with earth studies in this country, who will be greatly missed.

As stated by Dr. G. K. Gilbert in the May 12th issue of Science, Howell was the pioneer for the United States in the modeling of relief maps. As his work is the most widely distributed and best known of any in American institutions and has greatly influenced the prevalent conception of the subject, a brief analysis of it may be of interest.

Howell made the best and most ornamental relief maps we have. They were true to the maps which were represented, and were finished and lettered in an exceptionally decorative style. Dr. Gilbert mentions that Howell's work "was not distinguished for its artistic quality." The use of the term "artistic" is frequently misleading. Howell's work certainly showed skillful craftsmanship and "finish." For many years he employed an expert whose lettering was the most elaborate to be found on relief-map work. Dr. Gilbert further states that the work was "realistic wherever the material from which he worked was full." In one instance where a relief containing a breakwater was made, an actual specimen of rock taken from the stone foundation was introduced; this was realism but not "naturalistic," both the scale of detail and the material were not in keeping with the rest of the work.

"Naturalistic" is the term applied to the truthful reproduction of natural topography as distinguished from the conventional or diagrammatic map-method. The most obvious difference in the two classes of work is that the naturalistic gives the appearance as

well as dimensions of the place represented. The naturalistic principle calls for rational procedure throughout, toward the end that the result shall not only reproduce shapes and measurements, but characteristic expression of the land as well. The procedure must be rational according with natural laws, to bring about naturalistic results.

The subject of the representation of the earth's surface in relief is to-day little generally understood. It is one with a dual basis, the earth sciences on one hand, with the principles and application of art on the other. As paleobotany rests on both geology and botany, so the subject of land representation in relief has its rational basis on a knowledge of the lands and the principles and applications of landscape art. Each place chosen for representation in relief is a subject in natural history presenting a problem whose rational solution as such depends upon a comprehensive study of the locality with its meaning and possibilities as representative of earth form, and an adequate treatment as such natural phenomena or landscape, throughout the entire process of modelling and coloring. Simple and reasonable as may be this view little application of it seems to have been made in the land relief work produced in this country. Without a conception of the naturalistic basis as a guide, the mechanical turning of map data into a raised form, however accurate and complete the process may be, is machine-like drudgery. With the naturalistic conception which has been rarely well appreciated by those not versed in the motives of art, the work becomes rational and definite. Each subject under this light is a problem involving natural phenomena, whose adequate solution requires deduction from field observation applied to the special requirements of the work, with due recognition of the established principles of good art.

Relief maps are plentiful, but as yet naturalistic models of land forms are scarce. (In our museums there are few specimens of naturalistic earth models. Neither the government Geological Survey nor the National Museum has yet undertaken or exhibited this class of work. In the United States, geology and geography are to-day practically without natural history specimens of their greater forms.)

Howell was a man whose fortune it was to be little troubled with artistic sensibilities, his work in land relief could be compared to that of an anatomist engaged in making anatomical models, indeed he dealt in this work, and his product played quite the same relation to figure sculpture that relief maps bear to naturalistic models.

Relief maps in the making of which Howell stood at the head, have their place, but they do not fulfill that of the naturalistic model and the two distinct principles of work which each represents need not be confused. The raised or relief map is a form of diagram, a conventional representation of topography made by raising the signs on a map into relief, as indicated by its symbols. It is mechanical and can be largely produced by a machine. In the French military service it is so done. The purpose of the naturalistic model is to represent nature, not maps; it corresponds to figure sculpture and landscape painting, and aims to give not only correct dimensions, but a character and likeness of the special part of the world represented. The raised map is like the engineering diagram, special and very limited in its application. The naturalistic model contains all the data of the relief map and much more in addition, and its fields of use and influence is correspondingly broader.

Had Howell been an artist-naturalist as well as geologist, his work must have developed along different channels, for the naturalist mind will not be satisfied with the diagram as a representation of the expressive surface of the earth. That Howell tried to satisfy his clients, who, as Dr. Gilbert writes, "were numerous among the investigators and teachers of geology and geography," is without doubt, and had this influence been that of men well versed in art or its applications as in architecture, landscape gardening, sculpture or painting, it must have tended to direct his work toward a naturalistic conception.

The men who have done most to develop the subject of representation in land relief have invariably had artistic instincts and training as well as a technical knowledge of earth form. Professor Albert Heim, the most eminent geologist of Switzerland, an artist by disposition, may be regarded as the world's pioneer in the rational interpretation of relief work on the lands and the principles of naturalistic earth representation. Schrader, of Paris, geographer and artist, has contributed to the progress; Imfeldt, engineer and artist, has produced remarkable work among the mountains of Europe. Had Professor W. H. Holmes brought his own rare geologic and artistic ability to bear on this subject there is little doubt that the United States would today stand high in the work that has been produced in the most accurate, complete, and expressive means for representing the face of our earth, the naturalistic land model.

G. C. CURTIS

BOSTON,
June 1, 1911

A FUND FOR PUBLIC SCHOOL BETTERMENT IN PITTSBURGH

Two years ago a generous friend of education placed in the hands of a small commission a fund of $250,000, the income from which was to be used for public school betterment in the city of Pittsburgh of which Dr. John A. Brashear is chairman. The commission sought and obtained the advice of many of the foremost educators as to best means of helping the grade schools in the way of increased efficiency, with particular reference to the betterment of the social, physical and moral improvement of the students, as also their preparation for life's work.

As a result of many conferences, it was decided to send 70 selected teachers to various summer schools in this country with instructions to take only those studies which tended to greater efficiency in the lines above noted, and at the same time to conserve their own health by combining rest and recreation with their summer courses. As a result very interesting and valuable reports were brought back by at least 85 per cent. of those who were sent away for study, and the school year just passed has demonstrated the fact that the teachers came back with increased enthusiasm and a desire to share the benefits derived from their studies with their fellow teachers.

With such satisfactory results from last year's labors, the commission decided upon the same general plan for this year—and after a most careful study of the nearly 500 applicants for scholarships—from the 1,700 teachers of the city—one hundred and thirty-five have been selected and will be sent to the following institutions:

Columbia University	21
Harvard University	21
Cornell University	11
University of Pennsylvania	4
University of Chicago	6
Chautauqua	13
Pennsylvania State College	2
University of New York	3
Grove City College, Pa.	5
University of Pittsburgh	
Long term	8
Short term	35
Chicago School of Applied Arts	1
New York School of Applied Arts	1
New York School of Philanthropy	1
New York Kindergarten College	1

With a surplus of the fund left over from last year the commission has organized a vocational bureau to look after the interests of the boys and girls who must leave the grade schools to earn a livelihood which promises so well that we hope to show its great value to the new school commission, which will take charge of our public schools on the first of January, 1912, and induce the commission to make it an integral part of the public school system.

Associated with this, though not directly connected with it, a hospital school for the study of defective children has been doing splendid work.

HONORARY MEMBERS OF THE AMERICAN PHYSICAL EDUCATION ASSOCIATION

THE American Physical Education Association at its recent meeting passed the following minute:

The American Physical Education Association wishes to place on its records an expression of its regret and sorrow at the loss, within the past year, of three of its honorary members.

These three men have made large contributions to the science of human welfare and have helped greatly in establishing certain fundamental principles on which physical education rests.

One of these men was our neighbor and friend, Edward Hitchcock, of Amherst. He was one of the founders of this association, a man of heartiness, sympathy and common sense; eager and untiring in his work for young men, catholic and optimistic in his love for humanity; unconscious of the evils of the world, for he was always looking for the good; a brother to every soul struggling upward. He worked for his college, for his state and for the nation. While he always worked from a scientific basis he was a moral force rather than a scientist; he was a great teacher rather than a discoverer.

The second was the man who inspired more scientific study of man in the last thirty years, perhaps, than any other of the English-speaking race, Sir Francis Galton, of London. Of a family famous throughout the world for intellectual achievement he added much to its fame. He was endowed with a high ability in mathematics and his method of percentile study of vital statistics opened a new field in anthropometry, while his mechanical genius brought into working form many instruments for testing size, strength and working power. He saw the work to be done and he had a marvelous power to see the best manner of doing it. He has pointed out the road to many a man who could not see clearly, for his vision knew no bounds and physical capacity was his only limit.

The third member, whose memory will go with us as a cheering influence, was Angelo Mosso, of Turin. As a physiologist he first turned scientific attention to the interrelations of mental and physical activities. His methods of study and research were original and he developed many ingenious mechanical devices for recording changes in the human body that were due to mental and physical action. His special contribution to America was on "Psychic Processes and Muscular Exercise" at the request of President Hall, of Clark University in 1899.

As these masters of thought and leaders in the search for truth pass from our membership it should quicken our sense of responsibility in the work of the future for our department and make us more zealous for all good work for humanity, the study of which is the noblest task of the mind.

J. H. McCurdy
J. W. Seaver
P. C. Philips

SCIENTIFIC NOTES AND NEWS

The building named for Dr. Edward Williams Morley at the Western Reserve University and devoted to the departments of chemistry and geology, occupied this year for the first time, was opened for formal public inspection during commencement week. The building contains a tablet, bearing testimony to Dr. Morley's work in science, and to his thirty-seven years of active service in Western Reserve University.

Dr. Charles L. Parsons, professor of chemistry at the New Hampshire College, has received the doctorate of science from the University of Maine.

Dr. William G. Davis, professor of orthopædic surgery in the University of Pennsylvania, has been given the doctorate of laws by Lafayette College, and Dr. P. H. Musser, professor of medicine in the same institution, the degree of doctor of laws by Franklin and Marshall College.

Dr. Samuel Sheldon, professor of physics and electrical engineering at the Brooklyn Polytechnic Institute, has received the degree of doctor of science from Middlebury College, from which he graduated in 1883.

Professor W. M. Davis, first president of the Harvard Travelers Club, has been awarded the club medal for his work as a traveler and geographer.

The German emperor has bestowed on Professor Ehrlich the title of excellency and has appointed him an active privy councillor. The German physicians who have hitherto received this appointment are Koch, von Behring, von Bergmann and von Leyden.

Dr. Emil Godlewski, professor of agricultural chemistry at Cracow, has been elected a corresponding member of the Paris Academy of Sciences.

PROFESSOR WALDEYER, the eminent anatomist of the University of Berlin, will celebrate the fiftieth anniversary of his doctorate on July 22.

DR. ERICH MARTINI, who has been studying the bubonic plague in the far east for several years, has been visiting in New York City, before returning to Germany.

DR. GEORGE E. HALE, director of the Mount Wilson Observatory, has returned to this country after a prolonged visit to Europe.

DR. H. C. COWLES, of the department of botany at the University of Chicago, sailed in June to spend six months in Europe. He is to attend the British Association, in connection with which there is to be an excursion of plant geographers in England. He will spend some time in France and Switzerland, and will attend the Tenth International Geographical Congress in Rome, October 15–22.

DR. CHARLES J. CHAMBERLAIN, of the department of botany at the University of Chicago, will leave Vancouver in September for a visit to New Zealand, Australia and South Africa, returning April 1, 1912. His principal object is to study Cycads in the field and to collect material, not only of Cycads, but of other Gymnosperms as well, for detailed study, and also to pay special attention to Pteridophytes. The expedition is being made under a grant by the university.

DR. W. W. STOCKBERGER, of the Bureau of Plant Industry, Washington, D. C., sailed, on July 8, for Hamburg, and will spend three months in special agricultural investigations in Germany, Austria, France, Belgium and England. He will also attend the International Conference on Genetics which will be held in Paris in September.

DR. ARTHUR ORLO NORTON, assistant professor of education at Harvard, is writing a history of the German universities, and he is now in Italy to consult the libraries, especially in Florence and Padua.

THERE will be held a Congress of Monists at Hamburg from September 8 to 11, with Professor Ernst Haeckel as honorary president, and Professor Wilhelm Ostwald as presiding officer.

Nature reports that at the meeting of the Association Internationale de l'Institut Marey held on June 6, the resignation of Professor Kronecker as president was received. The members of the association elected Professor Charles Richet as president, and Dr. Augustus D. Waller as vice-president. The Institut Marey is under the patronage of the Associated Academies. It is situated in the Parc des Princes, Boulogne-sur-Seine, Paris, and contains laboratories, library and living rooms for the accommodation of workers. The acting director is Dr. Lucien Bull.

A MONUMENT to John Stuart Mill is being erected at Avignon, where he resided during the last years of his life, and where he died in 1873.

DR. G. JOHNSTON STONEY, F.R.S., born in Ireland in 1826, eminent for his contributions to astrophysics, died on July 5, at his home in London.

DR. HARRIS EASTMAN SAWYER, A.B., A.M., Ph.D. (Harvard), assistant chemist in the Bureau of Chemistry until he removed to New Hampshire on account of pulmonary tuberculosis, the author of contributions to the chemistry of sugar and alcohol, died on July 5, aged forty-three years.

MRS. ESTHER HERRMAN, a patron of the American Association for the Advancement of Science and for many years a regular attendant at its meetings, a liberal benefactor of the scientific societies of New York City, died on July 4, in her eighty-ninth year.

ACCORDING to the daily papers the earthquake of July 1 did considerable damage at Lick Observatory, on Mount Hamilton. The 36-inch telescope was moved three-quarters of an inch out of place on its concrete pier, but was restored without trouble. The case of the Riefler clock was wrecked and minor damage was done to the working parts. The chimneys of the observatory buildings were injured and a brick structure which houses a number of astronomers was cracked so as to

be unsafe for occupancy. The shock was the most severe that has been felt at the observatory.

A telegram received at the Harvard College Observatory from Professor R. G. Aitken, of the Lick Observatory, states that a comet discovered by Kiess was observed by Kiess July 6.9794 Greenwich mean time in

R.A. $4^h\ 51^m\ 51^s.8$
Dec. $+ 35° 15' 02''$

The comet can be seen with an opera glass. It is moving southwest, and has a visible tail.

The United States Weather Bureau is forming in its library, at Washington, a collection of meteorological photographs, and will welcome additions thereto from all parts of the world. The following classes of pictures are among those desired: (1) views of meteorological offices, observatories and stations; (2) pictures of meteorological apparatus; (3) portraits of meteorologists, views of their homes and birthplaces; (4) views showing the effects of storms, inundations, freezes, heavy snowfall, etc.; (5) cloud photographs; (6) photographs of optical phenomena (rainbows, halos, Brocken specter, mirage, etc.); (7) photographs of lightning and its effects; (8) photographs of meteorologically interesting pictures in old books, or of early prints and paintings (*e. g.*, contemporary pictures of the damage wrought by the great storm of 1703, in England). Persons who are willing to present such pictures to the Weather Bureau, or who will furnish them in exchange for Weather Bureau publications, are requested to address: Chief U. S. Weather Bureau (Library), Washington, D. C. It will add much to the value of these pictures if the sender will kindly note on the back of each as much pertinent information as practicable. On pictures of classes 4–7, inclusive, should be stated at least the date, hour and place at which each picture was taken, and the direction toward which the camera was pointed.

The interest manifested in recent developments in the study of heredity and evolution and the application of this new knowledge to plant, animal and human life has led to the presentation of a series of public lectures on these topics at the University of Chicago this summer. The lectures are open not only to students, but also to the general public. Three lectures were given in June. The first was a survey of general advances in science by Professor John M. Coulter, of the University of Chicago; another on "Variation, the Basic Factor in Evolution," by Associate Professor William L. Tower, of the University, and a third on "Variation, Heredity and their Relation in the Production and Perfection of New Races," by Dr. Tower. During July, the following lectures are being given in Kent theater:

July 5—"Mendel's Law of Heredity," William Ernest Castle, Ph.D., professor of zoology, Bussey Institution, Harvard University.

July 6—"Heredity, Selection and Sex," Professor Castle.

July 12—"Inheritance and Evolution in Higher Plants," Edward Murray East, Ph.D., assistant professor of experimental plant morphology, Harvard University.

July 19—"The Cytological Evidences of Germ Cell Constitution and Modification," Professor Coulter.

July 20—"Experimental Evidences of the Physical Constitution and Changes in Germ Cells," Associate Professor Tower.

July 26—"Inheritance of Physical and Mental Traits in Man, and their Application to Eugenics," Charles Benedict Davenport, Ph.D., director of the Station for Experimental Evolution, Carnegie Institution.

July 27—"The Eugenic Significance of the Geography of Man," The Eugenics Movement, Professor Davenport.

UNIVERSITY AND EDUCATIONAL NEWS

The Nevada State University has received $250,000 from Mr. Clarence Mackay, of New York City, and several of his friends, for the construction of a library and administration building.

Mr. Robert Christison has offered to contribute a further £1,000 (having already given £1,000) for the foundation of a chair for tropical and sub-tropical agriculture in the University of Brisbane.

THE salaries of professors in Oberlin College have been increased $200 each, and the salaries of associate professors $300 each, these increases to go into effect at the beginning of the next college year.

ALL of the qualified men in this year's graduating class in the College of Agriculture of the University of Wisconsin have secured positions and the requests for teachers are still coming in. The demand is especially strong from agricultural high schools both in Wisconsin and other states. Many of the requests are for men who have been brought up on farms, have had some teaching experience and also have had a thorough course in agriculture. The demand for such instructors in agriculture for high schools is very much greater than the supply. Even as early as four weeks ago most of the seniors had accepted positions as farm managers, as research assistants, or as teachers of agriculture in colleges and secondary schools. The average salary of the men who will teach next year in agricultural schools is $1,253.

PROFESSOR G. A. BLISS, of the University of Chicago, and Professor Max Mason, of the University of Wisconsin, have been appointed lecturers in mathematics at Harvard University, the former for the first, and the latter for the second half of the academic year.

DR. STEWART PATON '86, has been appointed lecturer in biology at Princeton University.

DR. GEORGE S. MOLER, has been promoted to a full professorship of physics at Cornell University.

R. C. MULLENIX, Ph.D. (Harvard), professor of biology in Yankton College, South Dakota, has been elected to a similar position in Lawrence College, at Appleton, Wis.

THE following instructors have been appointed at Princeton University: in the department of physics, C. J. Davisson and P. Rosenberg; in the department of electrical engineering, George Olshaussen, Ph.D.; in the department of biology, E. Newton Harvey, instructor in physiology; in the department of civil engineering, P. R. Bickford '11 and A. C. Cornish '11, instructors in civil engineering; J. H. Drummond '11, instructor in geodesy.

IN the Harvard Medical School instructors have been appointed as follows: Dr. Marshal Fabyan, in comparative pathology; Dr. F. P. Johnson, in histology and embryology; Dr. L. B. Nice, in physiology, and Dr. C. G. Page, in bacteriology.

DISCUSSION AND CORRESPONDENCE

CONCERNING THE "NEMATOCYSTS OF MICROSTOMA"

PROFESSOR KEPNER in a preliminary communication entitled "Nematocysts of Microstoma"[1] brings forward additional evidence showing that nettle capsules capable of subsequent discharge may be transferred from cœlenterates to flatworms much as they are from hydroids and actinians to eolids. The mechanism of this interesting and suggestive process is described in some detail, but it is hoped that this will be added to and clarified when certain proposed experiments have been carried out. Quite apart from its subject-matter, however, Professor Kepner's paper has an interest especially in the light of Dr. McDermott's recent "Plea for the Use of References and Accuracy Therein."[2]

Thus on page 271, almost seven lines are quoted and attributed to Boulenger, pp. 127–8. Not only are there no such pages in Boulenger's article,[3] but the words are taken from my own paper.[4]

In the next paragraph Professor Kepner states that the cuidophages of æolids deliver their nematocysts to the cnidocyst, whereas the endodermal cells of *Microstoma* deliver their nematocysts to the mesoderm. Unfortunately for the analogy, both Grosvenor[5] and I[6] have shown that the cnidophages after en-

[1] *Biological Bulletin*, Vol. XX., No. 5.

[2] SCIENCE, Vol. XXXIII., No. 857.

[3] *Quarterly Journal of Microscopical Science*, Vol. 55, No. 220.

[4] *Journal of Experimental Zoology*, Vol. 9.

[5] *Proc. Royal Soc.*, Vol. 72. This reference, correctly given here and in my earlier paper (1909), is incorrectly given as Vol. 22 in my second article (1910) and in Kepner's paper as well.

[6] *Ibid.*

gulfing a certain number of nettles, metamorphose directly into cnidocysts.

On page 275 Professor Kepner quotes Grosvenor through me, and adds "likewise no one can have witnessed the discharge of nematocysts of *Microstoma* when stimulated by pressure or acetic acid without looking upon them as organs of defense." Yet both Cuênot[7] and I proved that the defensive value of the nettles is slight if not negligible, whereas in 1909[8] I showed that under certain conditions (pressure, acetic acid) the discharge of nettles, even when enclosed in mother tissues or in eolids, may be no more the outcome of physiological stimulation than the explosion of a pistol is the result of a "stimulated" trigger.

In conclusion, Professor Kepner raises the question whether eolids have "acquired their method of dealing with nematocysts of cœlenterates through flatworm ancestry." To any one acquainted with the relationships, not only of molluscs, but of the particular ones under discussion, this question is a bit surprising, for not only is the supposed flatworm ancestry of the mollusca exceedingly problematical, but gastropods are not primitive molluscs, nor are nudibranchs primitive gastropods. One would certainly expect indications of the "nematocyst-habit" in primitive forms if there were any reasonableness in the phylogenetic point of view as applied to this problem.

Otto C. Glaser

Marine Biological Laboratory,
Woods Hole, Mass.,
June 22, 1911

[7] *Arch. de Zool. Exp.*, 4e S., T. 6.

[8] *Journal of Experimental Zoology*, Vol. IV.

DOUBLE MUTANTS IN SILKWORMS

To the Editor of Science: Referring to Professor Kellogg's interesting report on "Double Mutants in Silkworms," in Science of May 19, 1911, I would call attention to the fact that in his original publication the puzzling data regarding the inheritance of the white cocoon character is made clear by the assumption of two kinds of white, one dominant to color, the other recessive to color. In some of his original data certain individuals were evidently heterozygote for these two kinds of color. The recognition of both a dominant and a recessive white will also explain some of the puzzling phenomena reported in the more recent data.

W. J. Spillman

EXPLODED THEORIES AND THEOLOGICAL PREJUDICE

These are expressions used in Professor White's review of the new edition of "The Ice Age in North America." The exploded theories mentioned are "the Calaveras skull," "the Lansing man" and "the Nampa figurine." The error concerning the Calaveras skull figured by Whitney is freely granted in the book. But that there was a skull found as described, and other remains of man, in the auriferous gravels is still supported by a sufficient amount of convincing evidence to command attention.

As to the Nampa figurine, I am not aware that any one has brought anything but theoretical considerations to bear against the evidence originally collected by Charles Francis Adams and his associates immediately after its purported discovery; while the theoretical considerations are based, as I have shown, upon misunderstanding of the geological conditions. The cataclysm connected with the bursting of the upper barriers of Lake Bonneville, and the pouring of its waters into the Snake River valley must be reckoned with before the conditions reported at Nampa are set down as incredible.

The facts relating to the Lansing man are, I think, sufficiently set forth in the book to, at least, merit attention. If we are to accept every attempt to explode a theory as successful we shall soon come to a standstill in our discussions.

As to theological prepossessions, I only remark that it is as easy to impute *anti-theological* prepossessions, as to suspect theological bias. In any event the facts themselves should not be overlooked. Let us have fair play.

G. Frederick Wright

Oberlin, O.,
June 17, 1911

QUOTATIONS

THE PRESIDENT AND THE FOOD AND DRUGS ACT

WE have, for the past three weeks, called attention to the failure of the federal Food and Drugs Act, under the interpretation recently given it by the Supreme Court, to protect the public against loss, both in health and pocket, from lying claims regarding the curative effects of nostrums. As soon as the new interpretation became public, some of the more progressive members of Congress began to plan for getting an amendment to the pure food law that would specifically prohibit untruthful claims for therapeutic effects of drugs. President Taft, on June 21, took official cognizance of the blow that the Supreme Court decision had dealt the Food and Drugs Act by sending a special message to congress urging the very amendments that are needed to restore that law to its previous efficiency. Said the President:

> An evil which menaces the general health of the people strikes at the life of the nation. In my opinion . . . the sale of drugs under knowingly false claims as to their effect in disease constitutes an evil and warrants me in calling the matter to the attention of the Congress.
>
> Fraudulent misrepresentations of the curative value of nostrums not only operate to defraud purchasers, but are a distinct menace to the public health. There are none so credulous as sufferers from disease. The need is urgent for legislation which will prevent the raising of false hopes of speedy cures of serious ailments by misstatements of the fact as to worthless mixtures on which the sick will rely while their diseases progress unchecked.

To meet the objection that has been raised in some quarters that the curative effect of nostrums is a matter of opinion and not of fact and that the opinion will vary both as regards the so-called schools of medicine and also as to individuals of the same school, Mr. Taft says:

> No physician of standing in his profession, no matter to what school of medicine he may belong, entertains the slightest idea that any of these preparations will work the wonders promised on the labels.

And further:

> Of course, as pointed out by the Supreme Court, any attempt to legislate against mere expressions of opinion would be abortive; nevertheless, if knowingly false misstatements of fact as to the effect of the preparations be provided against, the greater part of the evil will be subject to control.

That the amendment suggested by the President will be fought by the "patent medicine" interests is to be expected. The Proprietary Association, as recently as June 17, sent out a letter purporting to give "the legal aspect of the Johnson case." The gist of the letter is contained in the following sentence that appears in it:

> As there is no science in therapeutics, the practise of medicine being based on opinion and not on definite scientific facts—any statement concerning the curative properties of any drug, chemical or medicine, is largely a "matter of opinion." . . .

In the opinion of the Proprietary Association—in other words, in the opinion of "patent medicine" makers—"the effect of the decision of the Supreme Court does not change or weaken the Food and Drugs Act in any particular."

President Taft, as evidenced by his special message, disagrees with the "patent medicine" men, for in his message he says:

> I fear that if no remedial legislation be granted at this session the good which has already been accomplished in regard to these nostrums will be undone, and the people of the country will be deprived of a powerful safeguard against dangerous fraud.

We believe that the restrictions the President would have placed on the nostrum business are more likely to meet with public approval than the "wide-open" policy advocated by the makers of "patent medicines." Amend the act!—*Journal of the American Medical Association.*

SCIENTIFIC JOURNALS AND ARTICLES

THE *Journal of Experimental Zoology* for July contains two articles: "Assortative Mating, Variability and Inheritance of Size, in the Conjugation of Paramecium," by H. S.

Jennings, and "The Reproduction of Paramæcium Aurelia in a 'Constant' Culture Medium of Beef Extract," by Lorande L. Woodruff and George A. Baitsell.

The contents of the last issue of the *Philippine Journal of Science* in the section devoted to chemical and geological sciences and the industries contains articles as follows: "Philippine Firewood," by Alvin J. Cox; "Quinine Esters of Phenylarsinic Acid Derivatives," by K. J. Oechslin; "The Mechanical Analysis of Soil," by Wallace E. Pratt; "The Economic Possibilities of the Mangrove Swamps of the Philippines," by Robert R. Williams.

SCIENTIFIC BOOKS

Reptiles of the World. By RAYMOND DITMARS. New York, Sturgis & Walton Company. 1910. Pp. xi + 373; 89 plates, 1 colored.

Of the numerous popular books on natural history that have appeared recently, few probably meet a greater need than this comprehensive work on the reptiles of the world. It is thus fortunate that Mr. Ditmars has undertaken the task, for his long connection with the New York Zoological Park has given him familiarity with living examples of a large number of forms and a knowledge of the information desired by the class of people who will presumably find most use for the book.

The limits of one volume do not, of course, permit a full treatment of the subject, but, as a rule, the author has used good judgment in the selection of material. All of the large groups are defined, down to and including the families, and the more important genera and species are described. The less important families, *i. e.*, those of less general interest, are given but a brief description, the less important genera and species are omitted, and genera that contain a large number of closely similar species, *e. g.*, the Anoles and Sceloperi, are given a rather full description supplemented by a short account of a few of the better known forms. The book is thus not burdened with details.

The descriptions are brief, couched in nontechnical terms, and admirably supplemented by excellent illustrations from photographs, mostly of living animals. It is refreshing to find the habits so fully discussed. They are given nearly as much space as the descriptions (in some cases more), and even when it has been necessary to treat a group very briefly the general habits are often given. The range is outlined in each case, and about as fully as one can expect in such a work.

It is not easy to criticize the book when one keeps in mind its aim "to give in a popular manner a general survey of the reptiles of the world." Thus, while the lack of detail in many places and the too brief and general descriptions will be regretted by scientists, they can not be condemned, for they are unavoidable defects in a book of this kind. However, the author makes the further statement that "while the manner aims to be popular . . . it is at the same time, the writer hopes, everywhere in accord with the latest results of the scientific study of the subject," and there will be differences of opinion on this point.

In the first place, it is to be regretted that a more recent nomenclature has not been used. It goes without saying that a book of this kind can not give space to nomenclatural disputes, and it may even be admitted that it may profitably retain names that have been replaced, if the new names have not as yet become well established in the literature. But it seems to the reviewer that nothing is to be gained by adhering to old names when the new ones have become reasonably well known (*e. g., Lacertilia* for *Sauria, Ophidia* for *Serpentes, Eutænia* for *Thamnophis*), and particularly in a book that aims to present the subject, no matter how popularly, in its present stage.

Another criticism that may be made is that relatively too much space is given to the habits of captive specimens. The habits in captivity furnish only a general clue to the habits in nature, and, as a rule, the activities of a captive animal are only a small part of the normal activities. Thus one may deter-

mine by a study of specimens in captivity whether a lizard is herbivorous or insectivorous, but from such data it is not possible to determine the range of diet, and generally impossible to work out at all satisfactorily the habitat preferences, reproduction, etc. It may readily be seen that this is true by an examination of this book, for it is the food that captive specimens will take that is given in most of the accounts of feeding habits, and habitat preference and reproduction come in for very brief treatment. The author might very profitably have included summaries of the published notes on the habits in nature. On the other hand, it is only just to acknowledge that the observations on the habits of specimens in captivity are of value, not only to those who wish to keep live material but also to scientists, for even general information is desirable in the case of many forms. Thus, on the basis of his observations on captive animals, Ditmars refutes the often repeated statement that the iguanas (subfamily Iguaninæ) and *Basiliscus* are strictly herbivorous (that they are also insectivorous in nature is a fact that may easily be demonstrated by an examination of the stomach contents of wild individuals), and the observations on the breeding habits of *Elaps fulvius* and *Lachesis mutus* are distinct contributions to our knowledge of the habits of these species.

In some respects the book-making is very good. There seem to be very few typographical errors. The upper figure on plate 3 is upside down, and in the table on p. 100 the genus *Coleonyx* is placed under the family Uroplatidæ by a printer's mistake. But these are very unimportant errors. The most unfortunate thing about the book from this standpoint is the absence of appropriate headings. The book is divided into four "parts," dealing with the turtles, crocodiles, lizards and snakes, respectively, but aside from this division there are no subdivisions of the subject matter, if we except the fact that there are center heads to the sections on the structure of lizards, the family Boidæ, and the new world Elapine snakes. The names of the families considered are usually given as side heads and the common names given to families when used as side heads and the common names of the genera and species when beginning a paragraph are placed in small capitals, but this is not sufficient to break up the text conveniently, and it is very difficult to find the descriptions of particular forms. The author states that "the scope of the book prevents it from being, as a previous book ['The Reptile Book'] by the same author was, primarily a volume for identification purposes," and it is probably for this reason that the excellent arrangement of the former work was not followed, but the value of the book could have been greatly increased by the use of at least a general system of headings, such, for example, as the one employed in Knowlton's "Birds of the World." Another fault in the arrangement is that the plates are not referred to in the text, and, as they are often far removed from the descriptions of the species, they can not be conveniently found.

One may, however, easily overlook the defects in the book for it is a valuable contribution to the subject. It is a good popular account, as the author intends it to be, and at the same time it will find its place on the shelves of the general zoologist and herpetologist, both for its very excellent illustrations and for the information on habits that it contains.

Alexander G. Ruthven

Natural Vegetation as an Indicator of the Capabilities of Land for Crop Production in the Great Plains Area. By Homer Leroy Shantz, Physiologist, Alkali and Drought Resistant Plant Breeding Investigations. Bulletin 201, Bureau of Plant Industry, U. S. Department of Agriculture. Washington. 1911. Pp. 100; 6 plates and 23 text figures.

This first endeavor to apply the exact methods of quantitative ecology to the problems of agriculture meets with conspicuous and gratifying success. The author is as skillful as thorough in his use of instrumental and

quadrat methods, and he is especially fortunate in his application of the principles of the development and structure of vegetation to a complex vegetational problem. The close and careful analysis of water factors and the intimate correlation of the natural vegetation with them will cause the present study to long remain a model for work in similar fields. The value of the natural crop as an index of agricultural possibilities is so clearly worked out that it must henceforth be taken fully into account in the survey of a new region. The present bulletin merits further praise for the happy way in which the newest ecological facts are combined with a knowledge of crop production in such a fashion as to yield results usable by both the scientists and the layman. It gives further evidence of the fact that the best scientific work is the most practical, and that practise can be permanent or successful only in so far as it is scientific.

In laying down principles for the use of the natural vegetation as an indicator, correlation with the physical or chemical nature of the soil, with rainfall or with temperature is held to be impossible for the region of the great plains. As the ecologist would expect, the water content of the soil furnishes the most reliable correlation, as the most important and controlling of all direct factors in an arid region. The author is probably correct also in insisting that the entire vegetation is a better indicator of conditions than any single species of it. Since the structure of a plant group varies considerably, however, it is not improbable that further study will reveal a few species which are the essence of the group, and hence the clue to it. Indeed, this is not far from the method used, as shown by the terms short-grass land, bunchgrass land, etc. The second step in the problem is to correlate the native vegetation, which should always be regarded as a crop grown by nature, with the culture vegetation, *i. e.*, the crop production. This correlation, of which the ecologist requires no proof, is practically possible only in so far as actual experiments in cropping have been made. In an arid region, all cropping is essentially experimental, and the necessary evidence, quantitative in a large degree, is at hand.

The first essential in correlating vegetation and conditions is a careful analysis of the former into its formations, associations and societies. Over a vast grass-land area, such as the great plains, this is peculiarly difficult, not only because of the disturbing effect of succession, but also on account of the ease of migration in all directions. Two typical grass-land formations are recognized, the prairie grass formation of the prairies proper, which extends westward into the shortgrass formation characteristic of the plains. The prairie grass formation in its plains portion falls into three groups, here called the bunchgrass, sandhills mixed and blowout associations. The shortgrass formation comprises three associations, grama-buffalo grass, wiregrass and *Gutierrezia-Artemisia*. These associations are not all stable groups of the final association, but some, notably the blowout and wiregrass associations, are initial or intermediate stages of a succession. Indeed, it is the skillful working out of the time sequence of the various associations which has made possible the correlations suggested.

The typical short-grass association is made up chiefly of two species, grama grass (*Bouteloua oligostachya*) and buffalo grass (*Buchloe dactyloides*). It is characteristic of loam or clay soils, the so-called "hard lands," upon which the author has worked out in convincing fashion the essential water relations. A thorough study of rainfall, run-off and penetration, rate of water loss, non-available water, and root systems brings out clearly the fact that it is the slight penetration of the rainfall on hard land which controls the root development, and consequently the establishment of the plant. The roots are from 12–18 inches deep, corresponding to a penetration of little more than 20 inches after the heaviest rains, and a consequent water content which repeatedly falls to the non-available during the summer. In accordance with this, the shortgrass association is an indicator of a small amount of available water, of

a short season for growth, and of a relatively high nutrient content. In connection with the heavier rainfall in June and July, the nutrient content of shortgrass land too often produces a deceptively luxuriant growth of crops, which are cut short by dwindling water content in late July and August.

The wiregrass association is dominated by *Aristida longiseta.* It is found chiefly on sandy loam, or at least on soils intermediate between the sandhills and the hard lands. The soil texture in wiregrass land permits greater penetration of rain, available water occurs deeper in the soil, and deep-rooted species become possible. The roots of wiregrass are from 2–3 feet long, while its usual associate, *Psoralea,* reaches a depth of 5 feet. There is nothing, however, to exclude the short-rooted grasses, and two species of grama often occur in this association. The wiregrass association indicates more favorable conditions for crop production than any other group. The soil is sufficiently compact to prevent blowing, and is well-supplied with nutrients. Water penetrates readily to a fair depth, and water loss is lessened by the air content of the sandy surface.

The soil of bunch-grass land is sand, and it allows rain to penetrate to a greater depth than either the hard land or the sandy loam. It contains more available water than these soils, but is relatively poorer in nutrients. Owing to its loose structure, it blows readily, and methods of cultivation must take account of this fact. The runoff from the sandhills is negligible, and the water loss from the soil surface slow, owing to the formation of a mulch of dry sand. The typical species of the association, bunch-grass (*Andropogon scoparius*), develops roots to a depth of 4–6 feet, as is the case also with its most frequent associates. The density of bunch-grass seems to be in direct relation to the water supply, and consequently a fairly close cover indicates a higher water content and better agricultural conditions. When the bunches are scattered, the short-grass finds an opportunity to establish itself in the spaces, utilizing the water content of the first soil foot.

The final vegetation type of the region is the shortgrass association, which may be reached through various successions. Of the two common primary successions, one begins with lichens on disintegrated rocks, passes into the *Gutierrezia-Artemisia* association, and as the soil becomes finer, terminates in the shortgrass association. The pioneers in a blowout initiate a longer succession. As a consequence of rendering the sand more stable, they yield sooner or later to a mixed association of sandhill plants, and finally to the bunchgrass association proper. The effect of fires or grazing is to change the latter to the shortgrass association, often through an intermediate wire-grass stage. When an association is destroyed by breaking the soil, the first vegetation will consist of weeds, but this will soon be replaced by the association which ordinarily precedes the one destroyed. For example, when short-grass is broken, *Gutierrezia-Artemisia* or wire-grass will take possession, to yield again to short-grass in the course of two or three decades, bunch-grass or other sandhill vegetation will temporarily replace wire-grass, etc. The cause of this is readily found in the loosening of the soil, while the reaction which brings back the original stage is seen in the increasing stabilization of the soil.

From the standpoint of crop production, the largest yields are obtained during favorable seasons from the shortgrass land, but failures are also most frequent on it. Bunch-grass land produces the smallest yield in good years, but on the other hand crop failures are rare. Because of its intermediate position, wiregrass land is usually the most valuable of all, since its productivity is not far below that of shortgrass land in good years, and it has much of the advantage of bunchgrass land in dry years.

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Blumen und Insekten, ihre Anpassungen aneinander und ihre gegenseitige Abhängigkeit. Von Professor DR. O. VON KIRCHNER.

Leipzig u. Berlin, B. G. Teubner. Pp. iv + 436, 159 figs.; 2 pls. 1911.

The large amount of literature which has been produced on the mutualistic relations of flowers and insects by Sprengel, Darwin, Delpino, Hildebrand, H. Müller, E. Loew, Chas. Robertson and numerous other investigators, and especially the recent publication of Knuth's exhaustive "Handbuch der Blütenbiologie" and its translation into English, would seem to render superfluous any further general presentations and to leave room, at least for some years to come, only for very special studies. An examination of von Kirchner's volume, however, shows it to be a very concise and useful compendium. The author presents the entomological aspect of the subject more fully than is usually attempted in similar works, one whole chapter being set aside for this purpose, after an introduction and two chapters on the meaning of pollination, the various ways in which it is brought about and the peculiarities of insect pollination, or entomogamy. Then follows a chapter on the general adaptations of flowers to insects. The bulk of the work is devoted to a concise and interesting discussion of the various types of entomogamy (Chapters VI. to XII.) according to H. Müller's classification of flowers into those which bear pollen only and those which produce nectar, and of the latter into various subgroups according to the accessibility of their nectaries or the peculiarities which make them specially attractive to Diptera, Hymenoptera or Lepidoptera. The ability of the author to present matters clearly and briefly is well shown in his account of the classical cases of the yucca moth and the caprification of the fig, while his balanced and temperate judgment finds expression in the three concluding chapters of the work, which deal with floral statistics, the causes of the mutualistic adaptations of flowers and insects and the various hypotheses which have been advanced to account for the phylogenetic origin and development of floral structures. That rare thing in so many recent German books, a good index, is added. The text is well-illustrated with a number of large clear figures, mostly from drawings by the author. A few of these figures, however, are open to criticism, for example, Fig. 16. which represents the abdomen of the bee *Osmia spinulosa,* is up-side-down, and Fig. 10, representing the olfactory organs of insects, is woefully archaic and should be replaced in a future edition by an up-to-date illustration. It is to be hoped that von Kirchner's work will be translated into English so that it may become more useful to students in the United States and inspire further observations on the mutualistic relationships of our native flora and insect fauna.

W. M. Wheeler

SPECIAL ARTICLES

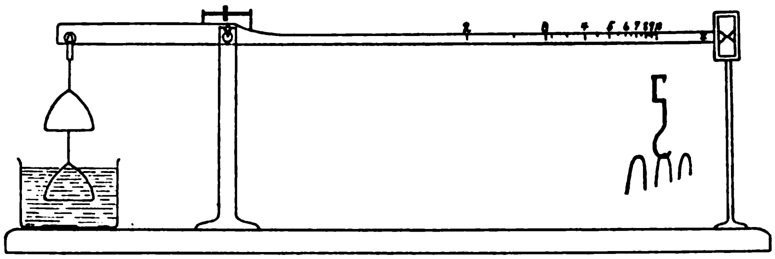
A NEW SPECIFIC GRAVITY BALANCE

The Specific Gravity of Minerals.—As the specific gravity is one of the most constant properties of minerals, its determination for pure massive specimens is one of the best means of identification. The accurate determination of specific gravity is a slow and painstaking process. A simple and rapid method which will give approximate results suffices for many purposes. The Jolly spring balance and a beam balance,[1] which depend upon the well-known principle of hydrostatics that a substance immersed in water loses in weight an amount equal to the weight of the water displaced, are fairly satisfactory. Two or three readings are made from which the value of the specific gravity is obtained by calculation. Though the calculation is simple enough it takes time and one is apt to make mistakes. The writer has designed a modification of the beam balance which it is believed will be found more convenient than these other forms, as the specific gravity is read off directly, the calculation being made once for all and recorded as graduations on the beam.

The New Balance.—The accompanying figure, which is one sixth actual size, shows the

[1] Brush-Penfield, "Determinative Mineralogy," sixteenth edition, p. 235. Geikie, "Structural and Field Geology," second edition, p. 428.

essential features of the balance. A brass support rests upon a wooden base and carries the knife-edge of a beam made of one eighth inch brass about twenty inches long. The short arm of the beam bears a knife-edge from which is suspended two pans about one and a half or two inches in diameter. When in use the lower pan is in water and the upper one in air. The end of the long arm of the beam rests within a guard supported by an upright which limits the motion of the beam. The long arm is graduated and carries a knife-edge counterpoise with hook at the lower end on which may be hung wire loops. In the figure the counterpoise and the wire loops are about one third actual size. The three knife edges are all in one line. Just above the fulcrum is a device for accurate adjustment.



The Graduation of the Balance.—The long arm of the beam is graduated so that the specific gravity may be read off directly. The formula for specific gravity by hydrostatic weighing is

$$G = A/(A - W);$$

where G is the specific gravity, A the weight in air and W the weight in water. Now if we use the same counterpoise with weight p, say, for both weighings, $A = px$ and $W = py$, where x and y are distances of the counterpoise from the fulcrum when weighed in air and in water, respectively. The equation then is

$$G = px/(px - py),$$

from which p may be eliminated, leaving

$$G = x/(x - y).$$

Hence the actual weights need not be known. When the weighings are in air, if the counterpoise is always placed at the same point (in the notch near the end of the beam) x becomes constant. Then the position of the counterpoise when weighings are made in water may be marked on the beam for different values of G. The equation given above may also be written

$$x - y = x/G.$$

The distance of the counterpoise from the notch in the beam or $x - y$ is equal to the length of the beam divided by the specific gravity. Thus if x, length of the notch from the fulcrum, is 15 inches (as in the present balance), when G is 2, $x - y = 7.5$ (15/2). So a point 7.5 inches from the notch is marked 2. When G is 3, $x - y = 5$ (15/3). A point 5 inches from the notch is marked 3 and so on. The graduation is in units from 2 to 10, in tenths from 2 to 4, in fifths from 4 to 6, and in halves from 6 to 10.

Adjustment.—The short arm, including the pans, is a little heavier than the long arm. But when the lower pan is immersed in water the beam should about balance, as a substance loses weight when immersed in water. Perfect adjustment is made by the device placed above the fulcrum. But this can be dispensed with, for the position of the beam depends upon the depth of water in the vessel. When no water is in the vessel the short arm is heavier than the long arm. So water is poured into the vessel until the beam is balanced.

Use of the Balance.—When in adjustment the balance will look like the figure, the lower pan being in water and the long arm of the beam free. (1) Place mineral in the upper pan. Place counterpoise at the notch near the end of the long arm and counterbalance

by adding wire loops. (A series of loops of varying lengths is needed.) (2) Next transfer the mineral to the lower pan. It will lose weight, so the counterpoise is moved toward the fulcrum until balance is restored. The specific gravity is then indicated by the position of the counterpoise on the beam.

Accuracy.—Tried with such minerals as quartz and calcite, this balance is accurate to about two units in the second decimal place for two or three grams of material.

A Portable Balance.—A convenient balance for rough work in the field may be made of a thin strip of wood, such as a foot ruler, driving a nail through for a fulcrum. To the short arm is attached a thin cord with rubber elastic for holding the mineral. The long arm is graduated so that the specific gravity may be read off directly as previously described.

The balance upon which the above description is based was constructed by Mr. F. A. Stevens, mechanician at Stanford University.

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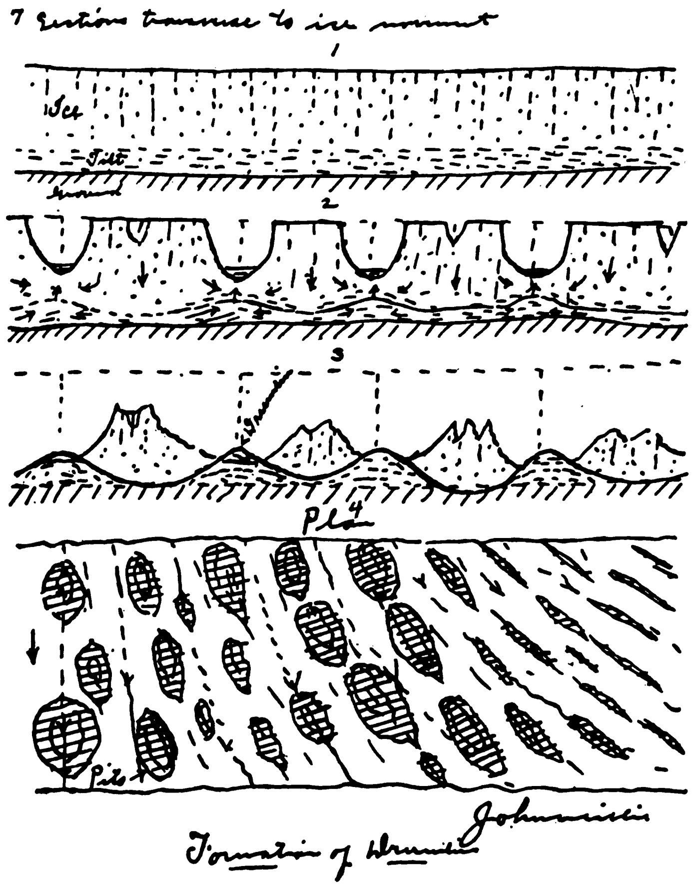
April, 1911

WHAT CAUSED THE DRUMLINS?

TO THE EDITOR OF SCIENCE: The following is a concise outline of a theory offered as an explanation of the process of formation of the peculiar smooth-contoured hills and ridges called *drumlins* and their allied topographic forms that occur in certain localities within the areas of the earth's surface formerly occupied by the ice sheet, notably in central New York, in southern Wisconsin, in portions of New England and of Canada, and in Ireland. These features of the surface have been the subject of much study and speculation and of a variety of theories, but so far as I can ascertain from available literature on the subject, the explanation here given has not heretofore been proposed.

During the period of dissolution of the ice covering certain glaciated areas, commonly called the period of "retreat" of the ice sheet, melting took place in the upper surface as well as on the front wall or slope. Owing to the strains in the ice mass produced by the forces that caused and attended the general advance of the sheet its internal structure had become such as to modify the process of melting from the upper surface. Before melting began there had been formed in the ice a system of vertical and parallel cleavage planes and fissures and the general direction of these conformed to the direction of the ice movement, owing to the forces above referred to. The assumed difference between a general ice sheet on a nearly horizontal surface and an individual glacier with a steeper descent in respect to cleavage is here to be noted. Changes of temperature with the changes of season may have had something to do with this structure. During the melting process the upper part of the ice sheet became deeply pitted or honey-combed on a somewhat gigantic scale because of the fissures and cleavage planes, and the pits were more or less elongated horizontally in the direction of these fissures and planes. As the melting proceeded on the internal surfaces of the pits, enlarging them, of course, the earthy matter in the upper parts of the ice, including stones, boulders, sand and gravel, dropped to the bottom of the pits and this material was thus subjected to a certain amount of water action and washing while the water drained away. With the enlargement and deepening of the pits and the removal of water the areas of ground ice and land surface beneath the pits were relieved of a large portion of the vertical pressure which the full thickness of the ice sheet had produced, while between the pits this pressure remained nearly the same as before melting started. The consequence was that a slow movement or flow of bottom ice towards the pits and an upheaval in the bottoms of the latter took place, and this lateral and concentering and upward ice flow at the bottom would, of course, carry with it the "till" material which was located principally in the lower portions of the glacial sheet, and a certain amount of the underlying material as well. There may have been periods during which the general melting was checked, due to seasonal changes of temperature or other

causes, while the above concentering ice flow at the bottom continued. Meanwhile the general advance of the remains of the ice sheet had not entirely ceased and this movement exerted a modifying influence in producing the surface forms that eventually resulted. Finally, as the ice faded away and the water drained off the englacial matter was quietly laid down in the smoothly rounded hills and ridges with intervening plane or hollowed surfaces that constitute the hitherto mysterious drumlin topography.



The forms of these surface features are doubtless attributable in some degree and in certain localities to the direct action of overmoving ice, either during formation or subsequently, but it seems probable that the gathering up of the drumlin material while in and under the ice by the movements described, and what may be termed its precipitation as the ice and water disappeared by melting and slow drainage respectively, were the principal formative causes. If the drumlin area was subsequently again covered by ice, this was probably of moderate thickness and was formed largely in place by accumulation of local snow fall in excess of the rate of melting, with a limited forward movement of the sheet; the effect on the surface being like laying down a heavy blanket over it and then dragging the blanket forward, rather than like pushing over the area a thick ice sheet with a definite front edge.

The original forms of the drumlins appear to have been remarkably preserved since the ice period by the conditions of soil and climate

favorable to a protecting covering of vegetation, and by a texture and composition of the material that are adapted to the absorption of water falling on the surface and to effective subsurface drainage, so that there has been little change by surface erosion or washing.

The forms of surface produced in any particular locality would, of course, be effected by a variety of conditions, such as the original topography and surface material of the drumlin area, the thickness of the ice sheet, the rate of its movement, and the nature, amount and location in the mass of the ice of the englacial material; the rate of melting and its degree of regularity and continuity, and the direction of the general movement of the ice sheet and the direction of the prevailing winds, since these would affect the action of the sun and atmosphere on the shape of the pitting in the ice. The rate at which the water was drained away would be a factor, too, as would also be the general climatic conditions during the melting period.

Besides offering a "workable hypothesis" as to the causes of the drumlin forms and their orientation, the above theory appears to explain many observed details that it has been heretofore difficult to account for satisfactorily. Among these may be mentioned the occurrence of the drumlins generally on approximately flat and level areas, the approximation roughly to uniformity in height in any given locality or group, and the nearer approximation to uniformity of spacing transversely to the direction of ice movement than parallel thereto where the drumlins are closely clustered; the internal composition of the drumlins, which is usually a compact till material with occasionally layers or strata of sand, gravel and boulders, these layers being usually near the top and conforming more or less closely to the curvature of the outer surface; the evidences of formation by lateral collection of local and recently deposited material; indications of lateral compression of the mass of the drumlin; the form of cross section sometimes seen which has quite flat side surfaces inclined to be hollow instead of convex and with a tendency to a sharp central ridge or apex; greater steepness of slope on one side than on the other in the drumlins of certain groups; more abrupt slopes or greater bluntness on the ends turned towards the source of the ice flow than on the other ends; the characteristic hollows between the drumlins and the troughs and hollows at their bases that are found in certain drumlin areas; and finally, what has seemed to the writer more puzzling than any other feature, *the departures from type forms;* the irregularities and variations in the shape and in the orientation of the drumlins, and their frequent close association with morainic deposits of quite different character. The variations of form are from greatly elongated slender ridges of very low relief to high hills with nearly circular horizontal contours—the "Bunker Hill" type of the Massachusetts region—and to hills only approximating to drumlins called "drumloids," while there are a few cases of drumlins elongated transversely to the direction of ice movement. Some characteristic drumlins are curved horizontally in their length, some appear to be branched or multiple, and many considerable departures in orientation from the local direction of movement of the ice sheet are to be found. These apparently abnormal shapes and positions are attributable to local peculiarities of the original land surface, and to the variations in the internal structure of the ice and in the direction of the fissures and cleavage planes. No doubt there are other causes.

As to the absence of drumlins from areas apparently favorable for their formation under the above theory, it can only be said at present that for some reason the various contributing causes were not so balanced or related as to produce the results herein described, and the ice withdrew or disappeared so as to lay down the englacial material in a sheet instead of gathering it up into drumlins. Possibly in certain areas drumlins were actually formed and subsequently washed away or otherwise destroyed.

JOHN MILLIS

THE RELATION BETWEEN PHOTOSYNTHESIS OF CARBON DIOXIDE AND NITRATE REDUCTION

THE first step in the utilization of nitrates for protein synthesis by the plant leaf is no doubt a reduction of the nitrate to the nitrite and finally to ammonia. The rôle played by sunlight in this action has been investigated from several sides. While Schimper tried to demonstrate that it was by means of light only, and in the cell containing chlorophyll, that nitrate reduction takes place, this theory has been somewhat modified by the researches of Zaleski, of Suzuki and especially of Godlewski to the effect that while nitrate reduction and concomitant protein synthesis take place to a much greater extent in the light, these reactions do also take place in the dark.

The writer has found that perfectly sterile aqueous solutions of potassium or calcium nitrate will keep in the dark, even at 95°, indefinitely without forming a trace of nitrite. If, however, a small quantity of colloidal platinum is added, a reduction of the nitrate soon sets in with the formation of nitrites and of ammonia, as made very evident with the Gries's and Nessler's reagent, respectively. This observation is quite in harmony with that of Schoenbein, who noticed a reduction of nitrates by means of juices of certain fungi, confervæ, etc. As most of the common forms of bacteria possess the property, to some extent at least, of reducing nitrates, it is of course very important to exclude all bacteria from the mixture.

That this reaction is brought about by means of hydrogen peroxide I am very much inclined to doubt, for absolutely no reduction takes place in the presence of hydrogen peroxide, with or without colloidal platinum; nor is the reaction in the least inhibited in vacuo. More probable does it appear that the platinum acts as follows, if there is something present to take up the hydrogen formed:[1]

$$Pt + 2H_2O \rightarrow Pt(OH)_2 + 2H.$$

The hydrogen is kept in the active, or nascent, state by the platinum, and reduces the nitrate directly. The platinum hydroxide in turn splits into platinum and hydrogen peroxide; the latter decomposes to water with the liberation of oxygen:

$$Pt(OH)_2 \rightarrow Pt + H_2O_2; \quad H_2O_2 \rightarrow H_2O + O.$$

The increased reduction of nitrates and of protein synthesis in the leaf in the light can be understood from the following observations. It was found that the reduction of potassium and calcium nitrates takes place with remarkable ease in the ultra-violet light of the quartz mercury vapor lamp, forming nitrite, ammonia and oxygen. The same action takes place, though more slowly, in the sunlight and even in diffuse or sky light. The action is greatly accelerated by colloidal platinum, though the latter is not necessary. Of special importance is the fact that the reduction of these nitrates results in a decidedly *alkaline* solution.

The theory that formaldehyde is the first product of reduction in the carbon dioxide appropriation has, of late, gained much substantiation. It must be remembered, however, that the next step, the polymerization of formaldehyde to carbohydrates takes place in alkaline solution only. Now while of course it is true that nitrate reduction in the leaf takes place in the dark, it can not be denied that this action is much greater in the light, and, as Schimper has shown, in the neighborhood of the chloroplasts; which must then result in a local alkalinity at these points. Thus not only are the proper conditions for carbohydrate synthesis established. but nitrogen is also produced in the best form and at the most available place for protein synthesis. No other explanation has been given so far as my information goes, and I can conceive no other way in which these very necessary conditions can be produced in the midst, it might be said, of all the acid products of sugar and protein metabolism. In this connection mention might also be made of a micro-chemical observation of MacCallum[2] who found potassium localized in the immediate neighborhood of the chloroplasts.

[1] See Mond and Ramsay, *Zeit. f. phys.-chem.*, **25**, 657. Bredig and von Berneck, *ibid.*, **31**, 254.

[2] *Jour. of Phys.*, **32**, 95, 1905.

But an alkaline area in connection with the chlorophyll can be of even greater importance. It is, in fact, highly probable that the reduction of carbon dioxide itself takes place in an alkaline solution, or better in the form of a bicarbonate. It will be remembered that while in the various attempts of Lieben,[3] Ballo[4] and of Fenton,[5] to reduce carbonic acid by chemical means, formic acid only was produced, the reaction took place either only with the alkaline bicarbonate or it was greatly accelerated by the presence of alkali.

While the experiments of Herchenfinkle,[6] and of Berthelot and Gaudechon[7] on the decomposition of carbon dioxide into carbon monoxide and oxygen in ultra-violet light are a valuable contribution to the chemistry of carbon dioxide, It must be borne in mind that in the plant leaf we are dealing with a substance of very different properties, namely, metacarbonic acid or its salts.

That certain plants are capable of liberating oxygen and synthesizing carbohydrates from solutions of alkaline bicarbonates has been demonstrated by Draper, Hassak, Nathanson, Anglestein[8] and others. These results can not be interpreted to mean that the plant is capable of utilizing the alkaline bicarbonates directly, but as the liberation of oxygen decreases with increasing alkalinity, it is clear from the equation,

$$NaHCO_3 + HOH \leftrightarrows NaOH + H_2CO_3,$$

that the plant is utilizing the H_2CO_3 formed by hydrolysis of the sodium bicarbonate. As McCoy[9] has shown, the amount of sodium hydroxide present in the above reaction is decreased to about one twentieth of the amount calculated for a normal hydrolysis, because of the secondary reaction:

$$NaOH + NaHCO_3 \leftrightarrows H_2O + Na_2CO_3.$$

Thus it is clear that the plant has considerable carbonic acid at its disposal, which it can utilize until the solution becomes too strongly alkaline. It must be noted that from the beginning, the action is taking place in an alkaline medium. Of special importance in this connection are the observations of Klebs[10] and of Hassak[11] who found that various forms of algæ growing in distilled water produce alkalinity therein during active appropriation of carbon dioxide in the sunlight.

In view of these facts, how then can the reduction of carbonic acid be pictured? Nef[12] has suggested that the first step in photosynthesis is as follows:

$$\begin{matrix}HO\\HO\end{matrix}\!\!>CO \rightarrow \begin{matrix}H{-}O\\ |\\ H{-}O\end{matrix} + \;>CO.$$

Now it is highly probable that the degree of dissociation brought about by light is greatly increased in the case of the alkaline bicarbonate:

$$\begin{matrix}K{-}O\\H{-}O\end{matrix}\!\!>CO \rightarrow \begin{matrix}K{-}O\\ |\\ H{-}O\end{matrix} + \;>CO.$$

This decomposition is, of course, similar to the decomposition of carbon dioxide into carbon monoxide and oxygen by means of ultra-violet light studied by Herchenfinkle. The potassium hydrogen peroxide decomposes, reforming potassium hydroxide, and liberating oxygen. The OC< is immediately reduced to formaldehyde by an action analogous to the catalytic reduction of the nitrates as given above:

$$M + 2HOH \rightarrow M(OH)_2 + 2H,$$
$$2H + \;>CO \rightarrow H_2CO,$$
$$2M(OH)_2 \rightarrow M + 2H_2O + O_2.$$

The detailed steps in the argument have not been fully developed in the above brief notice. Further work along these lines, as well as on the relation between plant acids and protein synthesis, are in progress, and will be published fully elsewhere.

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[3] *Monatsh. f. Chem.*, 1895 and 1897.
[4] *Berl. Ber.*, 1884, 6.
[5] *Jour. Chem. Soc. London*, **91**, 689.
[6] *Compt. rend.*, **149**, 395.
[7] *Ibid.*, **151**.
[8] Dissertation, Halle, 1910.
[9] *Amer. Chem. Jour.*, **29**, 437.
[10] *Unters. Bot. Inst. Tuebingen*, **2**, 340.
[11] *Ibid.*, 465.
[12] *Ann. Chem.* (Liebig), **357**, 253.

SCIENCE

FRIDAY, JULY 21, 1911

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE CAREER OF THE INVESTIGATOR[1]

SCARCELY more than a generation ago the graduate in medicine had his professional career marked out for him with a fair degree of definiteness. Private practise, as exemplified in the functions of the family physician, offered, apart from surgery, almost the only opportunity for the use of a medical training. During the past thirty years how extensively have medical activities become diversified. The paths of service that now invite the young physician are so varied that every graduate should be able to select a way for employing his peculiar powers to the best advantage. Quite apart from the conventional career of the physician, the surgeon, or the different specialists, are the opportunities for usefulness in the widespread movements which are socializing medicine. In professional service at hospitals and sanatoriums important work can be done; in boards of health, municipal, state and national; in public propaganda for temperance, for the prevention of infant mortality, for industrial hygiene, for the care of school children; in the campaigns against tuberculosis and venereal disease —in all these activities the possibilities of applying a medical education usefully to social needs are numerous and are yearly increasing.

Still another new career open to the young graduate is that of research in the medical sciences. For attracting young men into scholarly careers the medical sciences are, I suspect, at some disadvantage compared with other natural sciences.

[1] Address to the graduating class of the Yale Medical School, June, 1911.

Such subjects as zoology, botany and physics, for example, taught in the colleges, recruit their investigators from students who, in undergraduate days, before their life-purposes are definitely fixed, find the pure interest of the science a motive which determines their whole future. The medical sciences, on the other hand, are usually presented to students only after they have decided to fit themselves for practise in a highly attractive profession—that of mitigating the physical sufferings of their fellowmen. The medical sciences become thereby merely a means to a particular and predetermined end. And not infrequently the laboratory courses, because they defer the time of coming into direct and helpful contact with human beings in need, are regarded by medical students with impatience. To men who take that attitude, scientific investigation, because of its remoteness from the distress and the critical struggles of sick men and women, is apt to seem trifling. Perhaps they look upon the investigator with benevolent interest, or as a teacher they may like him, but they will, with fair certainty, remain indifferent to his scholarly occupation.

Because the attention of medical students is fixed so definitely on the practise of their calling they may entirely fail to understand the nature of scientific research, the sort of value which it possesses, or the incentives which impel men to its pursuit—in short, they may remain quite unaware of what productive scholarship in the medical sciences really implies. Yet the work of investigation is of prime importance to medicine, and it yields some of life's profoundest satisfactions to the man who pursues it. Among the multiplying opportunities open to persons with medical training, should not the career in research be better known and appreciated? It offers such important possibilities of serving not only one's own generation but all future generations as well, and it grants rewards so generously to those who embrace it that I propose to discuss with you some of its characteristics, and some of the qualities of those who pursue it successfully.

In a medical school as in other institutions of technical education the emphasis must be placed on what has been confirmed by experience, on what is well known and established. To point out repeatedly what is not known, or where lie the boundaries between our knowledge and our ignorance may be an interesting intellectual exercise, but it does not alleviate the sufferings of the sick or help to meet any immediate practical emergency. Nevertheless, it is our ignorance of disease and its conditions that limits absolutely our effective grappling with many of the most distressing afflictions of mankind.

The investigator is first of all one who thinks as much of what we are ignorant of as he does of what has already been made clear. His chief interest is in the territory which has not yet been traversed. Indeed he is to be classed with explorers and pioneers. For such men the complacent contemplation of things accomplished is intolerable—they chafe under the routine of established ways, and find the satisfactions of life in adventures beyond the frontiers. Harvey, among the first of modern discoverers, expressed the spirit of research when he wrote:

> It were disgraceful, with this most spacious and admirable realm of nature before us, and where the reward ever exceeds the promise, did we take the reports of others upon trust, and go on coining crude problems out of these, and on them hanging knotty and captious and petty disputations. Nature is herself to be addressed; the paths she shows us are to be boldly trodden; for thus, and whilst we consult our proper senses, from inferior advancing to superior levels, shall

we penetrate at length into the heart of her mystery.

And in another place he wrote:

Truly in such pursuit it is sweet not merely to toil, but even to grow weary, when the pains of discovering are amply compensated by the pleasures of discovery.

As children we all have an instinctive curiosity concerning the world about us, a curiosity which most of us gradually lose as we fit ourselves into the social conventions. The investigator is one, however, in whom this natural curiosity still persists. He has never got past the annoying stage of asking "Why?" The events occurring on every side which are matters of course to most men, startle him into wonderment. Why does the spinning top not fall? Why do animals breathe faster when they run? Why does disturbed water take the form of waves? Why do roots grown downward? Why does the mouth become dry when one speaks in public? Such are the questions that arise. The answers to them may be incalculably valuable to mankind. The microscope revealed to Pasteur strange organisms in bad-tasting wines. Why may not the disease of the wine, he asked himself, be due to the growth of these unusual germs within it? And later when he found germs also in silk worms, the further question was suggested, Why may not animals likewise become diseased in exactly the same manner? Whether the surmises of the investigator are true, the testimony of other men usually does not tell. He must turn to nature herself and put the idea to the test of observation and experiment.

This process of scientific inquiry involves peculiar qualifications which can not be disregarded by any one who thinks of trying it. Research implies in the first place *seeking again* over a region which has been previously traversed in order to learn what other men have done and the point where their labors ended. To make progress sure, therefore, previous records must be carefully studied. The failure to pay this just tribute to those who have labored before has not seldom led to fruitless effort or to vain repetition of work already well done. Marking the boundaries demands, then, a scholarly acquaintance with earlier discoveries; and the painstaking methods of the scholar must be used.

An ingenious and inventive imagination is a second requirement. It serves to indicate where the problems lie and also to suggest possible methods for solving them. The mind must be hospitable to all ideas thus presented, and yet it must receive them with skeptical scrutiny. By critically considering a plan for solving a problem it is often possible to select central tests, which are strategically related to the logic of the entire research. The physiologist Goltz is said to have done his most important work while fishing, for he employed that time in devising the crucially significant experiments.

Not all inquiries, however, can be ended by a relatively small number of crucial tests. Some investigations, like the important breeding experiments of de Vries, require years before they can be brought to a conclusion. Patience and an enthusiasm which is intelligently persistent are therefore essential qualities for the man in quest of new truths. The hopeful spirit is especially needed when, at the end of a long search, the investigator finds that he has only his labor for his pains—when his leading idea has proved to be false. That disheartening event is what Huxley called the tragedy of science—"the slaying of a beautiful hypothesis by an ugly fact."

The very soul of research, finally, is the highest degree of honesty. The investigator should see clearly and accurately with

an eye single to the truth. He has to consider not only the observations which fit his theory, but any others as well. The erratic cases invariably make trouble, but they are often disguised blessings. They may indeed be of far greater moment than those which have been anticipated, for they may point the way to entirely unsuspected facts. In my early studies on digestion I well remember how much I was annoyed by the repeated failure of some animals to show any signs of digestive activity during the period of observation. You can imagine how suddenly my vexation changed to deep interest when the troublesome inhibition was found to be an accompaniment of fright or anxiety which these animals showed while being looked through with the X-rays.

After the investigator has completed his examination of a group of questions which have interested him, his leading idea, his tests and his results must be described with scrupulous exactness. In thus reporting his work he should strive to be like clearest crystal, receiving the light and transmitting it untinged by any trace of color.

Scientific activity implies, of course, thorough disinterestedness. The investigator asks no favors and renders none. Any intimation that he act as a retainer or special pleader, any hint or suggestion that he restrict his explorations within certain limits lest he injure cherished traditions, is a step towards the confinement of the free spirit of intellectual inquiry. Rather than surrender that freedom of inquiry or the right of untrammelled announcement of fresh discoveries, men of science have in the past submitted to tortures and painful death, and you may be sure that, if need be, they will be ready to sacrifice themselves again. So exalted is the regard in which the man of science holds the ideal to which his life is devoted that he would find in these words of Fichte his solemn pledge:

> To this I am called, to bear witness to the Truth. My life, my fortunes, are of little moment; the results of my life are of infinite moment. I am a Priest of Truth; I am in her pay; I have bound myself to do all things, to venture all things, to suffer all things for her. If I should be persecuted and hated for her sake, if I should even meet death in her service, what wonderful thing is it I shall have done—what but that which I clearly ought to do?

The satisfactions of a life devoted to investigation, like the satisfactions of other careers, arise from the profitable use of one's powers. The peculiar powers which are needed for research I have just described. The employment of these powers in perfect freedom, and the immeasurably important results that flow therefrom, render the satisfactions of productive scholarship especially keen. These satisfactions we may now consider in relation to the special qualifications of the investigator.

The requirement that the investigator learn what other men have done before him in the field he seeks to enlarge gives him an unusual realization of the part he may be playing in the promotion of natural knowledge. Knowledge grows like the picture in the dissected puzzle. Every addition must fit the parts already arranged in order to possess significance, and also every addition makes possible the fitting of new parts whose positions in the enlarging picture become thereby suddenly revealed. One of the delights of research, therefore, is the sense that every bit of new knowledge finds its place in the structure of truth, and that sooner or later it will be required for the further building of that structure. The relation which the fresh contribution bears to that already established, the discoverer clearly sees; what relation it will certainly bear to further

contributions he may never know. How little did the men who studied the minute differences among mosquitoes, and who recorded the breeding habits of those insects realize their important rôle in abolishing the pestilence of yellow fever, and in bringing about the immense social and political changes which will result from that conquest.

Because every discovery becomes the basis for further discovery the imagination of the investigator is constantly stimulated. New facts suggest in turn other facts and point to unsuspected relations between things that have long been known. Bayliss and Starling's discovery of a natural chemical stimulant which induces secretion of the pancreas led directly to the explanation of continued gastric secretion, and also to finding the marvelous mechanism by which the mammary glands are prepared for the giving of milk. Thus, though the interests of the man of science seem at the moment narrow and restricted, they may nevertheless lead his thought out into many diverse realms of knowledge. These excursions of the imagination offer repeated suggestions for fresh adventure. The look therefore is always forward to what may be seen when the next step is taken. Seeking new things becomes in time a fixed habit. Past achievements neither satisfy interest nor hold attention—they become fused with the established routine from which it is a happiness to escape. The chance of beholding unsuspected wonders, or the possibility of finding that something imagined is really true is a constant incitement to further search and furnishes the zest and interest which are among the best rewards of the investigator.

Much happiness is found also in that single-mindedness, which, as we have seen, is one of the prime conditions in the pursuit of knowledge. It implies freedom from bigotry and prejudice, freedom from many of the influences and motives that to their regret men feel compelled to respect for purposes of prudence or policy. The intrusion of any other motive, save that of discovering and telling the truth, only tends to distract the mind of the investigator from his absorbing work. Faraday, whose life as a man of science was near perfection, wrote:

> Do not many fail because they look rather to the renown to be acquired than to the pure acquisition of knowledge and the delight which the contented mind has in acquiring it for its own sake? I am sure I have seen many who would have been good and successful pursuers of science and have gained themselves a high name, but that it was the name and the reward they were always looking forward to—the reward of the world's praise. In such there is always a shade of envy or regret over their minds, and I can not imagine a man making discoveries in science under these feelings.

Single-mindedness involves also a relative indifference to those motives of money-getting which prevail in commercial life. Success in research is fortunately not measured by money standards. And yet research flourishes best where there is free time to spend in thought and experiment. This time element is essential. The investigator may be made to dwell in a garret, he may be forced to live on crusts and wear dilapidated clothes, he may be deprived of social recognition, but if he has time, he can steadfastly devote himself to research. Take away his free time, and he is utterly destroyed as a contributor to knowledge. Free time and absence of the money motive, however, are found together only among the indolent poor and the indolent rich; and the observation has been made that neither of these classes is likely to contribute men of science. The industry of the investigator which results in new knowledge—knowledge in its unprofit-

able infancy—does not possess commercial value. Until recently indeed any money value of research had not been recognized. In the unappreciative past deplorable instances were known of struggles with poverty and want, going hand in hand with persistent loyalty to truth-seeking. Now, however, accumulated wealth is giving leisure for men to carry on their investigations free from the worries of uncertain livelihood. What they receive may not be much, but it is sufficient to permit them to look upon the scramble for wealth without envy or regret.

Fortunately, the provisions which enable men to pursue careers in science are found mainly in great universities, through which a stream of youth is constantly passing. There men who are moved by the instinct of investigation usually find their most congenial surroundings. Freedom of inquiry is the ancient tradition of the university spirit, leisure is recognized as a requisite for meditative observation, and the youth who resort to these centers of learning can be awakened to wonder at nature's hidden secrets, and can be stimulated to undertake with ardor the struggle to possess them. The peculiar richness of university life flows from memories of the transforming powers of the progressive and original minds who have by their eagerness for the truth and their freedom from worldliness inspired their students with their own ideals.

The greatest compensation, after all, for the truth seeker is the discovery of the truth. The value of labor that brings a revelation of new knowledge does not cease with the day; it remains as a permanent acquisition for the race. There is really great satisfaction to the investigator in this thought of the "durable results of the perishable years." But not only because of the permanence of truth is there pleasure in discovery—it is the marvel of beholding for the first time an unknown aspect of nature that fascinates men of science, and through difficulties and repeated disappointments holds them to the search. Only he who has had the experience knows the thrill that comes when that which was imagined proves to be true. One who was in Faraday's laboratory when the influence of the earth's magnetism on a wire conducting an electric current was first tested, has written: "All at once Faraday exclaimed, 'Do you see, do you see, do you see!' as the wire began to revolve, and I shall never forget the enthusiasm expressed in his face and the sparkling in his eyes." Kepler knew the joy which rewards the scientific discoverer when he completed the evidence that established his third law of planetary motion. Even one whose pulses have not quickened with the excitement of discovery can understand perhaps how he must have felt as he burst into triumphant exultation:

> What I prophesied two-and-twenty years ago, . . . what sixteen years ago I urged as a thing to be sought, . . . that for which I devoted the best part of my life to astronomical contemplations, at length I have brought to light and recognized its truth beyond my most sanguine expectations. It is not eighteen months since I got the first glimpse of light, three months since the dawn, very few days since the unveiled sun burst upon me. Nothing holds me; I will indulge my sacred fury. If you forgive me, I rejoice; if you are angry, I can bear it. The die is cast, the book is written, to be read either now or by posterity, I care not which. It may well wait a century for a reader, as God has waited six thousand years for an observer.

The scientific investigator may not seek particularly for knowledge which can meet at once some material need. Like the artist, he is more prone to direct his efforts towards that which will for the moment properly gratify an absorbing interest of his mind. If the new knowledge has,

when discovered, an immediate practical value, so much the better; but the direct search for understanding has certainly always proved the most effective motive in scientific labors. Because of this attitude the investigator should not be regarded as self-centered, or neglectful of duties to the general good. He is serving best his own generation in so far as he makes his standard of work thorough and honest. In so far as he does that, he is serving best future generations as well, for only thus can the results of his work be used later as a basis for further advancement. And since the interrelations of phenomena are so manifold the conviction is justified that every bit of honest work can finally be utilized in forming the body of truth. Although the investigator may labor, therefore, primarily to satisfy his own curiosity, and to secure for his craftsmanship that inner approval sought by every conscientious worker, nevertheless he is making permanent additions to the world's values. There is about his life, as Professor Royce has noted,

> an element of noble play. . . . One plays with silk and glass and amber, with kites that one flies beneath thunder clouds, with frog legs and with acid. The play is a mere expression of a curiosity which former centuries might have called idle. But the result of this play re-creates an industrial world. And so it is everywhere with our deeper curiosity. There is a sense in which it is all superfluous. Its immediate results seem but vanity. One could surely live without them, yet for the future and for the spiritual life of mankind, these results are destined to become of vast import.

Sometimes the worker in science lives to see his services used for the relief of human need. When Davy's studies of combustion enabled him to invent the safety lamp, he gave the invention freely to the world. He knew then that thenceforth for all time toilers in the mines could protect themselves against the dangers of destruction. There is no realm, however, in which the deep satisfaction of seeing discovery applied to human service is more likely to be experienced than in the realm of medical research. Consider how great must have been the joy of Pasteur and of Lister when they realized that the consequences of their investigations must lessen forever plague and pestilence and pain in men, and in the lower animals as well, and must permanently remove much of the blind struggle against mysterious agencies of disease and death. The letter which Walter Reed wrote to his wife on New Year's eve, 1900, at the end of his experiments on the transmission of yellow fever, tells something of the joy of such service—"The prayer that has been mine for twenty years," he concludes, "that I might be permitted in some way or at some time to do something to alleviate human suffering, has been granted! A thousand Happy New Years." And a thousand happy new years there will be for thousands of men and women and children, because of that one research in Cuba.

Through the employment of methods of scientific inquiry to medical problems more progress has been made during the past sixty years towards an understanding of the nature of diseases and their control than had been made in the previous twenty-three centuries. Think for a moment of what has been learned about diphtheria and tetanus, about meningitis and rabies, about tuberculosis and syphilis, about dysentery and cholera and typhoid fever. How fundamentally our attitude toward these diseases has altered as the discoveries of medical investigators have given us insight and powers to control. What great progress we have already made in this relatively short period towards the relief of man's estate. Still we must not forget that there are immense labors yet to

be accomplished. We are yet surrounded by innumerable mysteries, which can only be solved by persistent research. Not all men are fitted by temperament or training to engage in this great work, but more are thus fitted, I am sure, than are awakened to its opportunities. For those of you who are ready, here is a challenge to the supreme use of all your powers—to your imagination, your ingenuity, your patience and enthusiasm, and to your spirit of disinterested service. W. B. Cannon

Harvard Medical School

THE CONDUCT OF THE BUREAU OF CHEMISTRY

The committee on personnel of the department of agriculture, composed of W. M. Hays, assistant secretary; George P. McCabe, solicitor, and C. C. Clark, chief clerk, have made to the secretary of agriculture a report on the engagement of Dr. H. H. Rusby as pharmacognosist in which they come to the following conclusion:

> That Drs. Wiley, Bigelow and Rusby, throughout the negotiations for the readjustment of Dr. Rusby's salary, had in view the purpose to restore Dr. Rusby's rate of compensation to $20 per diem for days actually employed, thus to retain his expert services both in the laboratory and in court, which services were highly valued by the Bureau of Chemistry; to accomplish this purpose they made a secret arrangement, and, through Dr. Wiley, proposed to the Secretary of Agriculture the appointment of Dr. Rusby at a legal rate per annum, without disclosing to the Secretary that Dr. Rusby was in fact to be paid at an illegal rate, different from the rate specified in the appointment.

Based upon this report, the committee submits the following recommendations:

> 1. That Dr. H. H. Rusby, pharmacognosist in the Bureau of Chemistry at $1,600 per annum, be dismissed from the service, on account of irregularities in connection with his appointments and recommendation for appointment of Dr. William Mansfield as unskilled laborer.
>
> 2. That Dr. L. F. Kebler, chief of drug laboratory in the Bureau of Chemistry, be reduced from his present position as chief of the drug laboratory to a position and status in which he will have no authority to make recommendations regarding the salaries or periods of service of other employees, on account of irregular conduct in procurement of services of Dr. H. H. Rusby.
>
> 3. That Dr. H. W. Wiley, chief of the Bureau of Chemistry, and Dr. W. D. Bigelow, assistant chief of the Bureau of Chemistry, be given an opportunity to resign from the positions which they now hold in the Bureau of Chemistry, on account of irregularities in appointments of Dr. H. H. Rusby.

The attorney-general has recommended to President Taft the approval of the findings of the committee. It does not, however, appear to be likely that President Taft will dismiss Dr. Wiley, Dr. Bigelow and Dr. Rusby, for an alleged technical violation of the law. Dr. Rusby is a botanist and student of materia medica of high distinction and dean of the College of Pharmacy of Columbia University. If he was employed at a salary of $1,600 a year by the government, it was known to every one that he did not devote his entire time to government work. Dr. Wiley should be reprimanded if he has permitted a technical violation of the law, and the law should be altered so that scientific experts can be employed by the government on part time at a reasonable salary. And the president and the congress may very well take the opportunity to express their appreciation of what Dr. Wiley has accomplished for the public health.

SCIENTIFIC NOTES AND NEWS

Professor L. H. Bailey has tendered to the trustees of Cornell University his resignation as director of the New York State College of Agriculture. He has made no public statement about the matter except to admit that it is his intention to retire from teaching.

Surgeon-General Wyman has appointed Dr. E. C. Franklin, since 1903 professor of organic chemistry at Stanford University, to be professor of chemistry in the hygienic laboratory of the Public Health and Marine-Hospital Service.

The director of the Museo Nacional, Mexico, Sr. Garcia has resigned and Sr. Robelo

has been appointed in his place. Sr. Batres, inspector of antiquities, is succeeded by Sr. Rodriguez.

PROFESSOR CLYDE FURST, secretary of Teachers College, Columbia University, since 1902, has become secretary of the Carnegie Foundation for the Advancement of Teaching, succeeding Mr. John G. Bowman, who has become president of the University of Iowa.

THE Society of German Chemists has awarded the Adolf Baeyer plaque in gold and the interest of the Duisberg foundation to Professor Paul Friedländer, of Darmstadt, and the Liebig medal to Professor Paul Ehrlich, of Frankfort.

THE South African medal and fund has been awarded by the South African Association for the Advancement of Science to Dr. F. Peringuey, director of the museum at Capetown.

THE fiftieth anniversary of the connection of Dr. Carlo Reymond, professor of ophthalmology, with the medical faculty of the University of Turin, was celebrated on May 18, when a *Festschrift* was presented to him.

A PRIZE, to be known as the Professor Van Amringe mathematical prize, has been established at Columbia University, in honor of Professor Van Amringe, who last year retired from the head of the department of mathematics, after a service of fifty years. The prize has been endowed with $2,500 by Mr. George G. De Witte, '67, and is to be awarded to the student who is most proficient in mathematics during the first two years of the college course.

THE gasolene schooner *Polar Bear* arrived at Nome, Alaska, on July 12, having picked up on the way north A. C. Bent, Rolla H. Beck and Fred McKenzie, members of an expedition sent out by the Smithsonian Institution to gather specimens in the Aleutian Islands.

THE governor of Pennsylvania has appointed the following persons as the commission for the investigation and control of the chestnut tree blight in Pennsylvania: Mr. Samuel T. Bodine, of Villa Nova, Pa., vice-president of the United Gas Improvement Co.; Mr. George F. Craig, of Rosemont, Pa., of the firm of George F. Craig & Co., Philadelphia; Mr. Theodore N. Ely, of Bryn Mawr, Pa., superintendent of motive power of the Pennsylvania Railroad; Harold Peirce, of Haverford, Pa., agent New York Life Insurance Co., and Mr. Winthrop Sargent, of Haverford, Pa.

A NOTABLE addition to the facilities offered by Paris as a center of anthropological research is the Institute of Human Paleontology recently founded by the Prince of Monaco. In the new institute the Abbé H. Breuil, formerly of the University of Fribourg, occupies the chair of prehistoric ethnography and Dr. H. Obermaier, a former colleague of Professor Hoernes at Vienna, that of geology in its relation to prehistory. Professor M. Boule, of the Museum of Natural History, Jardin des Plantes, is the director.

THE South African Association for the Advancement of Science held its ninth annual meeting at Bulawayo from the third to the eighth of July, under the presidency of Professor P. D. Hahn. The association meets in four sections as follows: *Section A:* Astronomy, mathematics, physics, meteorology, geodesy, surveying, engineering, architecture and irrigation—president, Rev. E. Goetz. *Section B:* Chemistry, geology, metallurgy, mineralogy and geography—president A. J. C. Molyneux. *Section C:* Bacteriology, botany, zoology, agriculture, forestry, physiology, hygiene and sanitary science—president E. A. Nobbs. *Section D:* Anthropology, ethnology, education, history, mental science, philology, political economy, sociology and statistics—president, G. Duthie.

THE fortieth meeting of the French Association for the Advancement of Science will, as we have noted, be held this year at Dijon from July 31 to August 5, with M. Charles Lallemand as president. The sections of the association and their presidents are given in *Nature.* They are as follows: M. E. Belot, mathematics, astronomy, geodesy, mechanics; M. Galliot, navigation (civil and military), engineering; Professor Hurion, physics; Pro-

fessor Georges Lemoine, chemistry; Professor Violle, meteorology and physics of the globe; Professor Collot, geology and mineralogy; Professor Quéva, botany; Professor Bataillon, zoology, anatomy, physiology; Dr. Henri Martin, anthropology; Dr. Paul Courmont, medical science; Dr. Delherm, medical electricity; Professor Grimaud, odontology; M. Lucien Magnien, agriculture; M. Auguste Chevalier, geography; M. Paul Razous, political economy and statistics; Professor Beauvisage, pedagogy and teaching; Professor Jules Courmont, hygiene and state medicine; Dr. Simon, archeology. Inquiries may be addressed to the secretary of the association, Dr. Desgrez, 28 rue Serpente, Paris.

Professor Benjamin Franklin Thomas, professor of physics at the Ohio State University since 1885, died on July 4, at Boothbay Harbor, Me., after a short illness, at the age of sixty-one years.

The death is reported, at the age of seventy-three years, of Mr. J. D. Hooker, of Los Angeles, who took an active interest in astronomy, and gave to the Mount Wilson Observatory the 100-inch mirror now being ground for it.

The council of the Royal Anthropological Institute of Great Britain and Ireland sent to the recent Imperial Conference in London a memorial urging the establishment of an Imperial Bureau of Anthropology. The proposal is that the bureau should be established in London and that it should be managed by a committee composed of the council of the Royal Anthropological Institute and representatives of the governments of the British Dominions, of the Indian and Colonial Offices, and of those universities in Great Britain, in India and the colonies and dependencies of the empire where anthropology is systematically studied.

Mr. E. W. Hunnybun has presented to the Cambridge University his collection of drawings of the flowering plants of the British Isles, including 1,700 species and varieties. They are to be used to illustrate a new British flora by Mr. C. E. Moss, which will be published by the University Press. After the drawings have been used in this way, they are, with the letters of identification, to be preserved in the university herbarium.

Nature states that the arrangements for the meeting of the International Association of Seismology are now nearly complete. The following foreign states will be represented: United States, France, Russia, Austria, Germany, Hungary, Belgium, Switzerland, Spain, Greece, Italy, Holland, Rumania, Servia, Bulgaria and probably also Japan and Norway. At the opening meeting on July 18 the lord mayor of Manchester and the vice-chancellor of the university will welcome the delegates, and Professor Schuster, as president, will deliver a short address. On the same day the lord mayor will hold a reception in the Town Hall. The council of the university will give a dinner, and Dr. Shaw, the director of the Meteorological Office, will invite the guests to an excursion to view the observatory at Eskdalemuir. Among British men of science, the following have signified their intention of being present: Sir George Darwin, Dr. Milne, Professor Perry, Professor Lamb, Professor Knott, Professor Love, Mr. Oldham, Dr. Shaw and Dr. G. W. Walker.

Captain C. G. Rawling lectured on July 3, as we learn from *Nature,* before the Royal Geographical Society on the geographical results of the British expedition in Dutch New Guinea, which was organized by the British Ornithologists' Union, and was led by Mr. Goodfellow until illness compelled his return. The dense tropical jungle of the low plain between the mountains and the coast, the heavy rainfall and the sickness which incapacitated their carriers, prevented the travelers from reaching the higher portions of the range, but the scientific results, zoological, ethnographical and geographical, are most valuable. Captain Rawling and Dr. Marshall stayed for some time with the pygmy tribes of the lower hill ranges, and obtained much information concerning their customs, habits and general character.

The *American Museum Journal* announces that three very important anthropological col-

lections have been purchased. One from the Jesup Fund, is a series of rare objects from the Tsimshian Indians of the North Pacific coast collected by Lieutenant G. T. Emmons. This fills practically the only gap in our series from that important culture area. The second collection, made by Dr. Carl Lumholtz, in the little-known borderland along the Mexican boundary of Arizona, was purchased from the Primitive Peoples of the Southwest Fund. Among the unusual pieces in this collection are the costumes of a fool dancer, consisting of a mask, a crude and useless bow and other absurd trappings. This is of especial interest since this ceremonial character seems to connect the Papago culture with that of the Plains. Among other things may be mentioned a series of wooden plows introduced into Mexico from Europe by the early Spanish explorers. The Papago are the southern representatives of the Pima stock and were found still practising the art of basketry for which the Pima proper were at one time famous. The collection contains excellent samples of this almost extinct textile art. The third acquisition, gained through the Jesup Fund, is the General U. S. Hollister collection of Navajo blankets. In this series there are sixty-six pieces, some made before 1850. In materials and dyes there is a full representation: eleven blankets of bayeta, one of natural wool, eight of native dyes, seven of Germantown yarn, twelve of other commercial yarn, and eighteen in aniline dyes. The four varieties of weave practised by the Navajo are fully represented. There are also a few exceptional blankets, one of which represents in its design the Corn God copied from the sand paintings of altars of the Navajo. This collection, jointly with the series recently presented by Mrs. Sage and those belonging to the Lenders and Tefft collections recently presented by Mr. Morgan, give us a series of Navajo textiles fully representative both as to technique and design.

UNIVERSITY AND EDUCATIONAL NEWS

UNIVERSITY COLLEGE, Reading, England, has received an endowment fund of $1,000,000. The donors are Lady Wantage $250,000, Mr. George William Palmer and Mrs. Palmer $500,000, and Mr. Alfred Palmer, $250,000.

IT is announced in European journals that a new Russian university has been founded in Rostov on Don. The medical course will begin the coming fall. In Jellaterinburk will be established an academy of mines, and in Voronez and Samara academies of agriculture.

WE are requested to announce that a vacancy has recently occurred in the position of assistant professor of zoology in the College of Medicine and Surgery in the University of the Philippines. The entrance salary is $2,000 a year, but if a man of exceptional ability is secured as much as $2,500 might be given. It is expected that the holder of this position will engage in research work, and there are zoological problems of great interest that can be investigated in the Philippine Islands.

PROFESSOR LAENAS GIFFORD WELD has resigned his position as head of the department of mathematics in the State University of Iowa. He resigned the deanship of the College of Liberal Arts two years ago, soon after the accession of the present State Board of Education.

DR. ADOLPH I. RINGER, of the department of medicine of Cornell University, has been appointed instructor in physiological chemistry in the University of Pennsylvania.

AT Ohio State University John H. Schaffner, associate professor of botany, has been advanced to the position of professor of botany and head of the department.

DISCUSSION AND CORRESPONDENCE

THE IMPORT OF VITALISM

PROFESSOR JENNINGS's communication concerning "Vitalism and Experimental Investigation,"[1] like everything that he writes, does much to clarify the subject of which it treats. Yet I can not but think that some corners of the question still remain in a rather beclouded condition. It is apparent, at all events, that

[1] SCIENCE, June 16, 1911.

a previous letter of mine, upon which Professor Jennings is kind enough to comment, left room for certain misapprehensions. I venture, therefore, to ask for space both for the correction of those misapprehensions and for an attempt to carry the process of clarification a degree or two farther.

1. Professor Jennings is, of course, concerned with a question upon which I have touched only incidentally. I endeavored to discriminate and definitely formulate several doctrines which apparently tend to lose their identity under the common name of "vitalism"; Jennings points out that only one of the varieties of vitalism has any practical bearing upon experimental procedure. He seems, however, to suggest incidentally that this one is perhaps "the only kind worth distinguishing." Now, I should have supposed that any two or more things are worth distinguishing when they are in fact distinct and yet are likely to be confused. And that, in the use of the term "vitalism" and of its common antithesis "mechanism," a good deal of confusion has arisen seems to be beyond dispute. Most of the words ending in -ism, the current names of doctrines, need constant redefinition, or rather, constant care that they get and stay defined. "A French statesman," wrote Lord Morley recently, "some years ago told a public audience that if a patient linguist would only give them a rational dictionary of party appellations, such a one would earn a statue of fine gold." Men of science lack the facilities of French politicians for decreeing statues; but an exact and illuminating dictionary of party appellations is, if anything, even a greater desideratum in the domain of scientific and philosophical theories. Of the existing uncertainty about the meaning of "vitalism" and "mechanism"—and especially about the question whether the two terms are really to be taken as reciprocally exclusive, and as jointly exhaustive of the possible types of theory about organic processes—many examples might be given; I must be content with a few of especial interest in the present connection. Dr. E. G. Spaulding has, in a very interesting article, summarized the view of the late Professor Brooks upon the problem raised by Huxley's famous essay on "The Physical Basis of Life," in these words:

> Huxley's statement [that the properties of the protoplasm result from the nature and disposition of its molecules] can be granted to be valid, but . . . it does not mean that there is or ever can be an *a priori* deduction of the properties of protoplasm from those of its constituents; but that the connection between these must be bridged by induction. For the properties of the protoplasm, or, indeed, of the organism at any level, are not the additive result of those of the parts, but contain something quite new.

Now, with this position of his honored predecessor Professor Jennings seems to agree; in his illuminating address at Clark University[2] he said:

> As matter takes on new arrangements, its activities and reactions become different even though the properties of each constituent remain the same. . . . New methods of action arise when oxygen and hydrogen combine, producing water; new methods of action arise when a mass of brass and iron is arranged in the form of a clock. How, then, can it fail to be true in the case of organisms? . . . Hence we can not expect to find in the physics and chemistry of inorganic matter the full explanation of the properties of organisms.

The conceptions expressed seem to be identical. Now, Spaulding regards the position of Professor Brooks as "indicating the limitations of the mechanistic view of life"—though he adds that those limitations "are found as well in the inorganic realm."[3] Rádl (as Jennings has noted) expressly applies the name vitalism to this "idea that new methods of action arise when new combinations occur, taken in connection with the view that new combinations are found in living things." But Jennings regards this view as "far from a vitalistic one"; he calls it rather a "physico-chemical" or even "mechanistic standpoint."[4] Here, then, we find three expert writers on the subject giving two exactly contrary appellations to one and the same

[2] *American Journal of Psychology*, 1910, 349–370.

[3] *Popular Science Monthly*, February, 1911.

[4] *Op. cit.*, p. 364.

opinion. This can hardly make for lucid and fruitful discussion.

The prevalent confusion is illustrated once more in the "test of vitalism" proposed by another correspondent of Science.[8] We are asked to suppose an organism "instantaneously resolved into its constituent particles," and then put together again out of the same particles, each being impressed "with motions the same in direction and amount which they possessed at the instant of dissolution." Then, "if the reassembled body goes on as an organism as before, it will be proof that life is but the operation of . . . the ordinary mechanical and chemical forces." It surely would prove nothing of the sort. The possibility of the artificial production of life by chemical synthesis would logically be perfectly consistent with any of the several kinds of vitalism (including the doctrine of *Lebensautonomie,* which is what the writer quoted seems really to mean by vitalism), even with Driesch's notion of entelechy. There is in the nature of the imaginary experiment nothing indicated which excludes the hypothesis that an entelechy was originally in charge of the organism in question, that it, so to say, hovered hopefully about the scene during the process of decomposition, and promptly took charge of the proceedings again as soon as the original complex was recomposed. The proposed test, moreover, according to the proponent of it, permits "no sharp line of distinction" between one class of vitalists and the non-vitalists. It is not a wholly helpful way of defining non-vitalism to make it mean "one kind of vitalism."

2. The desirability of some effort to define and discriminate the "first" sense of vitalism—the doctrine of organic autonomy—is indicated by the fact that, both in the address cited and in his recent discussion, Professor Jennings seems to fail to distinguish that doctrine from something quite different and much less significant. This is shown in the passage already quoted about the "newness" of the methods of action characteristic, *e. g.*, of clocks; here the sense in which the uniqueness of vital phenomena is asserted by many vitalists is not differentiated from the sense in which every phenomenon under heaven may be called unique. The same misapprehension is shown in the concluding sentence of his letter, in which Professor Jennings (evidently referring to my "first" sense of vitalism) speaks of "the (for the working investigator) relatively inconsequential question as to whether anything happens in living things that doesn't happen in those not alive." This is undeniably a redundant question to raise, not only for working investigators, but even for otiose philosophers; but it is not a question which any one, so far as I know, has ever before proposed to raise. It certainly is not synonymous with the real question concerning the present possibility or intrinsic conceivability of the explanation of organic phenomena by the laws which describe the motion of inorganic particles—*i. e.,* of portions of matter *whether in or out* of those complexes called living bodies—which is the question over which "vitalists" and "mechanists" have been wont to debate. Clock-phenomena (to use Professor Jennings's illustration), however "new," are *not* autonomous with respect to the laws of physics; on the contrary, if you know the laws of physics (as a study of other inorganic bodies than clocks might reveal them to you) and know also the number, size, arrangement and composition of the pieces in a given clock (with due allowance for external forces), you can predict pretty well how the clock will behave. What the partisans of the doctrine of organic autonomy deny is that you conceivably ever can, from a study of the laws of motion of inorganic particles, arrive at a law from which you can predict how any living body will behave, *even if you know the number, size, arrangement and composition of the particles composing that body.* This question, about the ultimate relation of the laws of biology to those of the sciences of the inorganic, may not be susceptible of a demonstrative answer; but it is at any rate quite distinct from the banalities to which Professor Jennings refers. The question is one to which every reflective

[8] Science, June 2, 1911, p. 852.

mind would like to have an answer, if possible; it is one which many contemporary biologists (though chiefly through vaguely confusing it with other questions) suppose they have conclusively answered, in the one way or the other; and it is one upon which light may conceivably be thrown by the progress of experimental inquiry duly conjoined with logical analysis.

3. There is, as I have previously pointed out, another theory going under the name of vitalism which asserts organic autonomy, but also something more. It is the doctrine that certain vital phenomena are not dependent upon "any fixed configuration of material parts existing in the organism or cell at the moments at which the phenomena take place" —*i. e.*, that the same phenomena occur in a given organism in spite of profound modifications of the composition and configuration of the parts, through a sort of redivision of labor and redistribution of functions among the parts that remain. This doctrine is the substance of the conclusion which is suggested by Driesch's analysis of what is implied by the totipotency of parts in certain cases of morphogenesis, and by regeneration-processes.[6] This view seems to Professor Jennings tantamount to biological indeterminism and to a denial (so far as it reaches) of the principle of uniform causality. It is equivalent to an "admission that the principle on which experimental investigation is based breaks down when applied to biology."

A closer scrutiny of the doctrine's implications will, I think, disclose in it no such anarchical propensities. All that it logically need imply may be stated as follows: Within certain limits, at least some organisms are capable of realizing or maintaining the typical form of their species in spite of profound externally caused quantitative or qualitative changes in their physico-chemical mechanism; so that the "prospective potency" (at a given moment) of any single component particle is not a function of its own chemical nature *plus* the number and chemical nature of the other particles, but can be predicted only by means of a knowledge of the typical form of the species. But that typical form itself is a constant function of an original chemical compound of a specific type, viz., the fertilized egg of the given species. Hence, given the egg (or in the case of regeneration, the adult form) of a determinate species, everything about the process occurs in a regular, law-observing and experimentally investigable manner; only, *one* of the laws to be borne in mind is the law that the typical form of the species gets itself realized *despite* the radical mutilation of the mechanism and *by means of* a radical internal readjustment of the mechanism. There need in this be nothing arbitrary, nothing to baffle the purposes of the experimenter. It is open to him to ascertain by his usual methods how far, in a given organism, the morphogenetic units are "equipotential"; what are the limiting conditions of the organism's ability to maintain its typical form by the use of diverse internal mechanisms; and what are the steps of physical and chemical change by which the redistribution of functions and restoration of structure get accomplished. A "machine," for Driesch, is any system, each

[6] It was to this doctrine alone that I referred in the passage upon which Professor Jennings comments at p. 931, note 12; I was not, as I supposed the context made clear, attempting a summary of Driesch's whole system. But I appear to have expressed myself ambiguously, and am glad, therefore, to have Jennings call attention to the fact that Driesch's theory is "not limited to morphogenesis." It is, however, true that the most distinctive and novel thing in that biologist's doctrine is his conception of "harmonious equipotential systems"; as he himself declares, what is really characteristic in neo-vitalism is due "to the renaissance of experimental morphological inquiry, to the 'Entwicklungsmechanik' of Wilhelm Roux; all the new factual evidence for the doctrine of *Lebensautonomie* has been found in this field" (*Der Vitalismus*, 1905, p. 155). For a discussion of the import of Driesch's arguments from behavior, and their relation to his arguments from morphogenesis, space is lacking here. Though I think Jennings misconceives Driesch's position in ascribing to him a wholesale "experimental indeterminism," I do not wish to complicate the discussion with exegetical inquiries into the precise meaning of a rather difficult writer.

of whose parts performs its specific function, in relation to the action of the whole, only by virtue of its composition and its spatial relations to the other parts; thus, if those relations are sensibly altered, the whole will no longer function in its original manner. If this were true of organisms, their action would, in Driesch's sense, be "mechanical," even though the law of the action of the parts were not deducible from any law of inorganic mechanics.[7] But since some or all organisms are, at least to some extent, harmonious equipotential systems, their action is not mechanical in either sense—such is the essence of the argument. "It must be granted that a machine, as we understand the word, might very well be the motive force of organogenesis in general, if only normal, that is to say, only undisturbed development took place, and a taking away of parts of our system led to fragmental development."[8]

In all this argument for the non-mechanical nature of organic phenomena there is nothing whatever that necessarily "exempts from experimental determinism . . . that immense field of developmental processes which lies between the egg and the adult," or that necessarily nullifies the experimentalist's postulate that "when two cases differ in any respect there will always be found a preceding difference to which the present difference is (experimentally) due." The argument (whatever its worth) does not imply that different effects have the same antecedents; it implies only that, in an individual organism, the *same* type of effect (namely, the typical form of the species) may follow from *different* antecedents—the relation between the two sets of antecedents being such as to reveal the non-mechanical character of the action of both. It is surprising that this, of itself, should be regarded as violating the rule of causal uniformity, since that rule notoriously does not work both ways; the same effect (in the ordinary sense) need not always have the same cause. Even if entelechies are to be dragged into the situation, indeterminism need not follow, if only it be assumed (what nothing in the hypothesis precludes) that an entelechy always comes into action whenever a specific material complex has been formed; and that the occasions upon which, and the manner in which, the entelechy determines the subsequent action of that complex are uniform.[9] I do not say that Driesch himself clearly and consistently adheres to this assumption; but in so far as he departs from it, and gives color to the charge of indeterminism, he introduces a foreign element into his conception of a "harmonious equipotential system," and confounds the second sort of vitalism with yet a third essentially distinct one. And this is one of the confusions which it is needful to guard against in the discussion.

4. Let me briefly revert in conclusion to the original question concerning the meaning to be assigned to the term vitalism. Professor Jennings would apparently reserve that word for indeterminist theories, on the ground that these alone are likely to have much interest—the interest of the repulsive—for "the man of science at work with his two hands." It does not seem quite clear that the limitations of interest of even bimanous experimentalists ought to be erected into a canon of lexicography; yet one should welcome any canon which will impose upon the terms used in the discussion of vitalism single and definite and constant meanings. It is of no importance whether a given trisyllable denote one or another doctrine; it is of some real importance that it be not used indiscriminately to disguise the real nature of several distinct doctrines, and that these doctrines themselves, the distinctions between them, and their bearings both theoretical and practical, be clearly formulated and understood. So far as the tendency of present technical usage is con-

[7] Driesch himself does not seem to note the distinction here indicated, and accordingly frequently speaks as if he were arguing merely for organic autonomy in the ordinary sense.

[8] "Science and Philosophy of the Organism," 1908, I., 139.

[9] This uniformity would not imply (as the hasty reader may incline to suppose) that entelechy-determined action and mechanical action would be the same.

cerned, I am not sure that the meaning preferred by Professor Jennings is the most widely accepted one. Eisler, for example, in the last edition of his "Wörterbuch der philosophischen Begriffe" defines "Neo-Vitalismus" primarily as the doctrine which "betont die *Autonomie* und *Aktivität* der Lebensprozesse, die Unmöglichkeit diese restlos aus mechanisch-chemischen Gesetzen abzuleiten"; and though he adds to this formula (which he ascribes in common to Bunge, Wolff, Reinke, Hartmann, v. Uexküll, K. C. Schneider and Driesch) some peculiarly Drieschian details, these do not amount to a theory of "biological indeterminism."

Usage, however, is still too various and confused to settle the matter; and none of us has authority to legislate upon the subject. The term vitalism might, with real advantage to both biology and philosophy, be retired from service. Even if that desirable consummation be past hoping for, it should still be possible to persuade contributors to the discussion to bear in mind the ambiguity of the term and of the antithetic "mechanism," and to recognize and keep separate the several distinct issues which in much current use of those terms tend to become blurred and confused.

A. O. Lovejoy
The Johns Hopkins University,
June 19, 1911

SUBSIDENCE OF ATLANTIC SHORELINE

On page 906, of Science, No. 858, I observe certain statements of D. W. Johnson, of Harvard, maintaining that there is no decisive evidence of recent subsidence of the Atlantic coast regions, but, on the contrary, some beach-formations which would seem to prohibit such conclusion. This is all very startling, not to say iconoclastic.

The great shallow bays of our more southern coasts, such as Delaware, Chesapeake, Albemarle and Pamlico, having long estuary-like arms, which suddenly and bluntly terminate at their upper ends and there receive in every instance a stream of comparatively small size, might at first seem to be a somewhat puzzling geographic condition; but it can readily be accounted for through subsidence and in my opinion in no other way.

At the maximum of the last elevation of the coast, the Susquehanna River flowed southward, with sensibly more than its present volume, and emptied into the Atlantic near the present Cape Henry. A few miles above this point it received from the west a moderate stream following the direction of the present James River. Higher up another moderate stream, following the line of the present Potomac, joined the Susquehanna near the present Smith Point.

For some thousands of years, perhaps, constant denudation lowered and flattened out the land along these streams. A subsidence of the coast then began. The sea, entering the Susquehanna, formed at first a small bay which received both the curtailed Susquehanna and the James. With still further subsidence the ocean filled more and more of the river valley and those of its branches, until, after a subsidence which need only amount to some 75 feet, we find the long shallow Chesapeake and its lateral arms formed by the intruding ocean as we know them to-day. The same reasoning applies to the other bays mentioned. Further north these results are less manifest because of the more precipitous nature of the coast; but the great terminal moraine constituting the backbone of Long Island became separated from the mainland by the waters of Long Island Sound, and it is probable that Narragansett Bay was largely formed in the same way.

If the nature of these shallow bays and their long, wide, abruptly ending lateral arms, receiving in every case at the upper end a flowing stream, is not positive evidence of progressive subsidence of the coast in recent times, it would be difficult to imagine any satisfactory reason for the observed facts. The evidence seems, in fact, as plain as though written in bold characters for us to read.

Other evidence of subsidence is shown by the salt marshes, with perfectly level surfaces built up by vegetable débris at high-tide

level, while the deep streams meandering sluggishly through them do not shoal, but become continually deeper through a slight excess of depression of their bottoms, as a part of the area of general subsidence, over the fill due to sediment. This is a classic and very evident proof of actual subsidence, as valid now as ever. The subsidence has probably been very slow, possibly not over six inches in a century, but that it is real admits of no doubt. To ascribe these phenomena to the fluctuations of height of ordinary high tides is, to say the least, inadmissible.

THOS. L. CASEY

SCIENTIFIC BOOKS

Conservation by Sanitation. By Dr. ELLEN H. RICHARDS. New York, John Wiley & Sons. 1911. 8vo. Pp. 305. Cloth, $2.50. Illustrated.

Peculiar interest attaches itself to this work, as it is almost the last publication of one who has contributed very largely to the literature of modern sanitation. Mrs. Richards's books on water analysis are well known to a wide circle of readers. Her other books on the cost of cleanness, the cost of living, the cost of food, the cost of shelter, the chemistry of cooking and cleaning, home sanitation, etc., are equally well known to an entirely different circle of readers. To say that these books have had an important influence in molding modern sanitary thought, especially among women, is to put the truth but mildly.

"Conservation by Sanitation" is a laboratory guide for sanitary engineers in the study of air, water supply and the disposal of waste. It is divided into two parts. Part I., which comprises about three quarters of the work, is of a general character and adapted to a wide field of readers. Its style is discursive, perhaps too much so, but it covers many matters of interest and importance in the realm of sanitary science.

Especial prominence is given to the sanitation of air, which is regarded as "a neglected resource." The advantages of pure air and better ventilation in houses and factories is set forth. One chapter is devoted to the work of the sanitary inspector and the analysis of air.

Several chapters are devoted to the history of public water supplies, the development of the sanitary idea as indicated by the municipalization of water works, economic and sanitary efficiency of water works, protection of water supplies as a conservation of natural resources, the regeneration of a spoiled watershed, the interdependence of town and country, and efficiency of filtration. On many of these subjects the information given is disjointed, but is nevertheless instructive. Particular emphasis is placed upon the necessity of collecting water from a clean gathering ground and storing it in clean reservoirs. The uses of the chemical analysis of water are described at length, but one of the rather surprising features of the book is the conspicuous absence of references to bacteria and their importance in water supplies.

Two chapters are devoted to the disposal of wastes, including garbage, sewage and wastes from manufacturing establishments. The effect of dilution is considered at some length, but little space is devoted to works for the purification of sewage.

The first part of the book closes with a chapter on the education and position of the sanitary engineer in the progress of modern sanitation, in which emphasis is placed on the need of efficiency in the enforcement of health laws.

> The mechanical basis of modern life must come to the aid of moral and personal influence. It is not enough to tell men to do the right thing—they must be fenced in from the wrong thing. For this reason the public service engineer is the emerging leader in community welfare.

Part II. comprises a series of laboratory exercises and tests on the inspection of ventilation and the analysis of water and sewage. These notes are based on exercises prepared for the fourth-year sanitary engineering students at the Massachusetts Institute of Technology, where Mrs. Richards was for so many years an important member of the faculty.

G. C. WHIPPLE

Minnesota Algæ. I. The Myxophyceæ of North America and Adjacent Regions, Including Central America, Greenland, Bermuda, the West Indies and Hawaii. By JOSEPHINE TILDEN. Pp. iv + 328, pl. 1–20. 1910.

This book, with the modest title of "Minnesota Algæ," treats of the blue-green algæ of North America and adjacent regions. It appears as a Report of the Survey, Botanical Series, No. 8. As the author states in the preface, it is largely compiled from numerous publications, though she has also drawn on her long experience in the study of the algæ. It has been published chiefly for the purpose of encouraging students in the collection and study of this group of algæ about which so little is at present known in this country, and to provide students, who do not have access to the numerous publications, with descriptions of all the species thus far accredited to the region. Illustrations of many of the species are also presented which should aid in the determination. These illustrations are largely copied (by means of photographs and tracings) from the classic monographs by Bornet & Flahault, Gomont, etc., though some of them are original. The illustrations, therefore, in general should be valuable for their accuracy, though they have suffered somewhat from an artistic point of view.

The descriptions are said to follow, in general, those of Gomont, Bornet, Thuret and Flahault. Keys to the genera and species will assist the student in the recognition of the species.

Four paragraphs are usually given to one species. The first one gives the name of the plant with a few references to works where it is described. The second paragraph is usually a long one giving references to articles (with full title of the article) or works in which the plant in question figures in a list or description. Some synonymy is also mixed in with this bibliography of the species. As the author suggests, there is a certain convenience in having these references under each species, but they thus occupy a large part of the book because of repetition, and the example could probably not be followed in many cases except where funds for publication are freely available. The third paragraph gives a description of the species, while the fourth one gives the distribution by states or countries, including the particular local habitat, which in some instances is quite definitely indicated.

Since the use of double plates renders it impossible to have descriptions of figures on a page facing the plate, references to the figures would have been rendered much easier if names and corresponding figure numbers had been printed at the bottom of each plate.

It is to be inferred from the Introduction that the author contemplates another volume on the same group of algæ sometime in the future which is to be of a monographic nature. If the present work succeeds in interesting a sufficiently large number of persons in different parts of the country who have the time to collect, study and preserve the material in their region, and if the author can make a thorough and critical study of all this material, comparing it with type material or authenticated specimens in the herbaria of Europe, and bring it together with the accuracy, judgment and finish shown by some of her European predecessors, it will furnish us with an exceedingly valuable contribution to American algology. GEO. F. ATKINSON

A Study of the Absorption Spectra of Certain Salts of Potassium, Cobalt, Nickel, Copper, Chromium, Erbium, Praseodymium, Neodymium and Uranium as affected by Chemical Agents and by Temperature. By HARRY C. JONES and W. W. STRONG. Johns Hopkins University. Pp. 159, 98 plates. Publication No. 130, Carnegie Institution of Washington.

In this monograph the authors have recorded the results obtained from the study of about three thousand solutions of salts of potassium, with a colored anion, cobalt, nickel, copper, chromium, erbium, praseodymium, neodymium and uranyl and uranous uranium.

"The effect of the addition of free acids and foreign salts on the absorption spectra is studied at some length and in considerable detail and results have been obtained which

show that chemical reactions in general are probably much more complex than is represented by the equations which are usually employed to express such chemical changes." The effect of the nature of the solvents on the absorption spectra has been one of the chief points investigated in this work. It is shown that solvents which themselves do not absorb visible light may have a determining influence on the absorption of the dissolved substances. Well-defined "solvent-bands" have been discovered for water, the alcohols, acetone and glycerol. These bands are perfectly characteristic of each solvent, and their existence is regarded as strong evidence for the theory of solvation, upon which work has been in progress in the laboratory of the Johns Hopkins University for the past twelve years.

The experimental methods employed are essentially those used by Jones and his coworkers in previous investigations of absorption spectra. To the chemist probably the most interesting result obtained in this work is the evidence for the existence of a series of intermediate compounds in the course of a chemical reaction. When, for example, uranyl nitrate is transformed into uranyl sulphate by the addition of sulphuric acid the absorption bands of the former salt gradually shift over to the position occupied by the absorption bands of the latter. "In an example of this kind the bands can be made to occupy any position between the initial and final positions, and it seems probable that when a salt of one acid is transformed in this way into a salt of another acid, there is a whole series of intermediate systems or compounds formed."

At the present time no method is known for separating these unstable intermediate compounds, but the spectrographic evidence is such as to warrant the assumption of their existence and confirms the view that the ordinary chemical equation represents only the initial and final stages in a series of reactions.

The influence of the solvent on the absorption spectra of the different solvents examined is most interesting. The absorption spectra of the same salt in different solvents are frequently very different and in a mixture of two solvents the bands characteristic of each appear, the intensity varying with the relative amounts of the two solvents present. The authors attribute the change in the absorption spectrum accompanying change of solvent to solvation rather than to differences in the dielectric constants of the solvents. The authors call attention to the fact that "probably no salts show more characteristic bands than some of the uranous salts in the various solvents: water, the alcohols, acetone and glycerol." The discovery of a strong "water-band," λ 4274, in the absorption spectra of the neodymium salts is likely to prove useful in future spectrographic investigations. This band is intense and is free from neighboring bands.

Cases have been found where it is possible to break up the absorption bands into finer bands by chemical methods. An example is afforded by solutions of uranyl salts in acetone. By the addition of hydrochloric acid the uranyl bands are broken up into fine components, several of the bands becoming triplets and some doublets.

The authors summarize this action of hydrochloric acid and other reagents in the following statement: "The presence of foreign reagents causes the uranyl bands to become more intense and, in most cases, narrower." It is further noticed that these bands are slightly shifted toward the red.

Spectrograms have been made at different temperatures varying from 5° to about 80°. As a result of this phase of the investigation the authors conclude that rise in temperature is accompanied by an increase and a broadening of the general absorption in aqueous solution, the bands at the same time becoming more intense. The ninety-eight plates of absorption spectra given at the end of the monograph are a credit to both the investigators and the printer. The data compiled within this and the preceding monographs by Jones and Uhler and Jones and Anderson will undoubtedly prove of much value to future investigators in the field of light absorption by solutions.

FREDERICK H. GETMAN

A Descriptive Catalogue of the Marine Reptiles of the Oxford Clay. Part I. By Dr. C. W. Andrews. Published by the British Museum. 1910. 4to, pp. 1–205, pls. i–x.

The marine Jurassic formations of England and Germany are exceptionally rich in fossils, both vertebrate and invertebrate. There is scarcely a museum in Europe and not many in America in which the visitor fails to see skeletons of ichthyosaurs, plesiosaurs or sea crocodiles from one or another of the classic localities. The British Museum collections of Jurassic marine reptiles far surpass those of any other institution, and preeminent among them is the splendid series of Upper Jurassic age, obtained from the clay-pits near Peterborough by Mr. Alfred Leeds. "Both in the number of species represented," Dr. Andrews observes, "and in the perfect preservation of their remains, the Leeds collection far surpasses any other single collection of Mesozoic vertebrates, especially one in which all the specimens are from one horizon and from a restricted area. Not only marine forms but remains of terrestrial reptiles, including several species of dinosaurs, have been obtained." The completeness and abundance of the material and fine preservation of the bones has enabled the author to give a very thorough description of the osteology of the principal genera, and he has exercised a commendable conservatism in the creation of new genera and species. In the present volume the ichthyosaurs and plesiosaurs are described; the second volume will comprise the pliosaurs and crocodiles.

There is but one genus of ichthyosaurs, *Ophthalmosaurus,* with which *Baptanodon* of the Jurassic of Wyoming is regarded by the author as congeneric. This is the most highly specialized member of the order, with extraordinarily large orbits, almost toothless, with broad short forepaddle, and hindpaddle much reduced in size. A swift and powerful swimmer, proportioned like the modern porpoises, it was also capable of diving to great depths, as shown by the peculiarities of the auditory apparatus, fitted to withstand great water pressure. In contrast to this swift pelagic reptile, the plesiosaurs were rather slow moving, comparable with the sea-turtles more nearly than any other modern animal, and in Dr. Andrews's opinion they lived mainly at the surface and at no great distance from the shore, and, as might be expected, show a much greater variety in form than the ichthyosaurs. All are referred to the Elasmosauridæ, but in *Muræonosaurus* the neck is greatly elongate, the head relatively small and the whole animal about twenty feet long; in *Cryptocleidus* the neck is of more moderate proportions, the head relatively larger and forepaddle broader, while the total length is about twelve feet. Two new genera, *Picrocleidus* and *Tricleidus* are of intermediate proportions, but much smaller size. The definitive generic characters are chiefly based upon the structure of skull and shoulder girdle. The diversity of form in these Upper Jurassic plesiosaurs is much less than in their Cretacic successors, best known from the western United States, but they are decidedly more specialized than the Lower Jurassic *Plesiosaurus* and its allies, as is indicated in Dr. Andrews's reference of all the genera to the Cretaceous family Elasmosauridæ, and most clearly demonstrated in the progressive modification of the shoulder girdle.

Dr. Andrews's memoir is illustrated by ten plates and over ninety line drawings in the text, and by diagrammatic restorations of the skeleton of the three best known genera and a photograph of the mounted skeleton of *Cryptocleidus.* It is in most respects very near to the reviewer's ideal of what a monographic description ought to be—based upon abundant and well-preserved material, the amount and character of which is clearly specified and listed in detail, well illustrated, clear and concise in form, conservative in nomenclature and species making, failing not to distinguish fact from theory, certainty from probability. The British Museum and the author are to be congratulated upon the appearance of this fine monograph.

W. D. Matthew

SCIENTIFIC JOURNALS AND ARTICLES

THE July number (volume 12, number 3) of the *Transactions of the American Mathematical Society* contains the following papers:

E. R. Hedrick: "On properties of a domain for which any derived set is closed."

J. E. Rowe: "Important covariant curves and a complete system of invariants of a rational quartic curve."

A. B. Coble: "An application of Moore's cross ratio group to the solution of the sextic equation."

G. A. Miller: "On the use of the co-sets of a group."

W. H. Roever: "The southerly deviation of falling bodies."

Virgil Snyder: "An application of a (1–2) quaternary correspondence to the Kummer and Weddle surfaces."

O. E. Glenn: "On semi-discriminants of ternary forms."

THE June number (volume 17, number 9) of the *Bulletin of the American Mathematical Society* contains: Report of the April meeting of the San Francisco Section, by H. C. Moreno; "Invariant conditions that a *p*-ary form may have multiple linear factors," by O. E. Glenn; "The general term of a recurring series," by Arthur Ranum; "Relations between the Gramian, the Wronskian, and a third determinant connected with the problem of linear dependence," by D. R. Curtiss; "Note on the integration of series by Lebesgue integrals," by W. A. Wilson; Review of Eisenhart's Differential Geometry, by G. A. Bliss; Review of Stuyvaert's Cinq Etudes de Géométrie analytique, by E. G. Bill; "Shorter Notices": Duhem's Etudes sur Léonard de Vinci, by D. E. Smith; Young's Fundamental Theorems of the Differential Calculus, by N. J. Lennes; "Notes"; "New Publications."

THE July number of the *Bulletin* (concluding volume 17) contains: Report of the Chicago meeting of the society, by F. N. Cole; "On the negative discriminants for which there is a single class of positive primitive binary quadratic forms," by L. E. Dickson; "Iterated limits of functions on an abstract range," by R. E. Root; "Note on a Mersenne number," by H. J. Woodall; "Shorter Notices"; Brenke's Advanced Algebra and Trigonometry and Davisson's College Algebra, by Arnold Dresden; Loria-Schütte's Spezielle algebraische und transcendente Kurven, by C. L. E. Moore; Encyklopädie der Elementar-Mathematik, erster Band, by F. W. Owens; Netto's Determinanten and Timerding's Theorie der Kräftepläne, by J. B. Shaw; Föppl's Technische Mechanik, Band 6, by E. B. Wilson; "Notes"; "New Publications"; "Twentieth annual list of papers read before the society and subsequently published"; Index of volume.

SOME MISTAKES BY THE WRITER AND OTHERS, WITH A PLEA FOR PROMPT AND EXPLICIT CORRECTION IN A JOURNAL OF GENERAL CIRCULATION AMONG SCIENTISTS

LONG contemplated, the immediate occasion of this article is indicated in the following statement, substantially a copy of a letter dated January 31, 1911, and addressed to Dr. Ales Hrdlicka, curator of the Anthropological Division of the U. S. National Museum.

I submit two calvas and this statement. In February, 1880, there was received at my department of Cornell University (then including human anatomy) the head of a mulatto of medium color. From the features it was believed to be a male, and in my absence the age was estimated by Professor S. H. Gage at between 28 and 35 years.[1] The brain was hardened *in situ* by Professor Gage by the injection of the preservative through the arteries, and then removed by the sagittal division of the calva.[2] The calva was prepared and dated by Professor Gage, and later given the number, 322, of the brain.[3] The rest of the skull, with the

[1] Professor Gage has since informed me that he thinks the head was sent from New York by the late Dr. M. J. Roberts; also that there was never any doubt in his mind as to the sex; probably it was stated in the letter of transmission.

[2] As described in the "Reference Handbook of the Medical Sciences," first edition, Vol. 8, p. 199; second edition, Vol. 2, p. 375.

[3] All the parts and organs of one individual receive one and the same accession number. The brain is represented in the "Handbook," Figs.

soft parts attached, was preserved for a time but cannot now be found. Of late years brains have occupied most of my attention. The mulatto calva was misplaced in one of the cases of skulls; I even forgot that it was in two parts, as are several others. I did remember, however, that it was unusually thin, even for a Caucasian. In the spring of 1909, when preparing my address on the "Brain of the American Negro," by way of emphasizing my warning not to generalize from single specimens, which might be quite exceptional, I took the thickest calva in the collection, that of a white murderer (Ruloff, No. 965) and the thinnest, which I supposed to be that of the mulatto of 1880. It then bore no number or other mark of identification, but it has since been numbered 6070. It and the calva of Ruloff were shown at the conference and afterward photographed side by side as Fig. 1 of the published address. Since my retirement, while revising the museum and its records for my successors, the mulatto calva of 1880 has been found, bearing Professor Gage's original date and the number, 322; of its identity there can be no doubt. Of course a correction and explanation must be published.[5] First, however, I desire to ascertain the extent of the misapprehension that may have been caused by the unintended substitution of the calva 6070 in Fig. 1 of my address. Does it, either in the published figure (which is all that readers of the address have to judge from) or in the actual specimen, exhibit any feature incompatible with its being from the mulatto? For a frank opinion I shall be very grateful.

Following is the report of Dr. Hrdlicka:

The calva marked C. U., 322, Male Negro, presents nothing that would suggest that race. The thinness is very unusual. It was probably from a small and not very strong individual. It is deformed in an uncommon way, due to premature synostosis of large portions of the coronal suture on each side, the like of which I have not seen in either negro or mulatto. The parietal eminences are much more pronounced than is generally the case in the negro or even the mulatto, and the occiput is without any protrusion, which is also unlike what is most commonly observed in the two classes named. The calva marked C. U., 6070, may well have been from a male. It bears several fairly plain negro characteristics and would well agree with being that of a mulatto. The evenly rounded forehead, the narrowness of the anterior half of the vault, the premature, not physiological, obliteration of the sagittal suture, are all strong signs pointing in this direction. The ventral conformation of the frontal part of the vault is typically negro-like.

Summary and Comments.—(1) Calva 6070 is not (as supposed when the address on the brain of the American negro was prepared and printed) that of the mulatto, 322, obtained in 1880. There is no documentary evidence that it was from any individual of the African race. Hence it must not be employed in any racial generalization.

(2) But it is about as thin as the true mulatto calva, 322; both of them are exceptionally thin for either race, while calva 965, from a white murderer, is exceptionally thick for either race.

(3) According to high anthropologic authority calva 6070 "bears several plain negro characteristics, and would well agree with being that of a mulatto."

(4) The publication of this correction has been delayed in the hope to ascertain the identity of calva 6070 from former students and assistants in various parts of the country.[6]

(5) No similar error has occurred among the specimens in my charge. I alone am to blame. Self-correction is not a pleasant task; still less pleasant, however, would be the consciousness that silence might mislead others and eventually cast a doubt upon the accuracy of our records, hitherto unimpeached.

2. In 1875, while formulating a "provisional arrangement of vertebrates according to cerebral [encephalic] and cardiac char-

4766, 4767, 4770 and 4772 of the first edition, and Figs. 762, 764, 765 and 766 of the second.

[4] Proceedings of the First National Negro Conference, pp. 22–66, with 13 figures. Reprinted.

[5] In addition to the copies distributed by the committee in charge of the conference I have given a thousand copies to scientists and personal friends.

[6] The lower part of the skull has both petrosals excavated as if for the study of the internal ear. This condition and the extreme thinness may recall the specimen to some one not already applied to.

acters,"[7] and while predisposed toward a reduction of the interval between the two great divisions of teleostome fishes, I stated that the olfactory bulbs contained cavities not only in the ganoids named but also in the teleostean genera, *Perca, Scomber* and *Anguilla,* and pictured the cavity, rhinocele, in the first named genus, as of considerable size and as surrounded with substantial walls; (plate 3, Fig. 14). Later observations showed that this cavity was an artifact produced by the beaded bristle employed as a "seeker."

This correction does not militate against the recognition of slight depressions at the base of the sessile olfactory bulbs such as were described and figured by me in 1876 (*A. A. A. S. Proc.,* p. 258 and Figs. 12 and 13); much less does it contravene the representation of the rhinocele by a cavity having only a membranous roof on the dorsal side of the bulb itself when sessile, or on the dorsal side of its peduncle when the bulb is located at a distance from the rest of the brain.

3. My participation, up to 1876, in the then prevailing non-recognition of "the morphologic importance of the membranous or other thin portions of the parietes of the encephalic cavities" has been clearly admitted and sufficiently regretted in a paper[8] entitled as in the words quoted above. The general remarks in that paper on self-correction and on the private correction of others are commended to scientists generally.

4. In the articles on the brain in both editions of Buck's "Reference Handbook of the Medical Sciences" I systematically followed the plan, then and still somewhat unusual, of enumerating the defects of the illustrations. Such as have been subsequently noted in vol. 2 of the second edition are now specified.

(*a*) Fig. 670. The convexity of the albicans should have been shaded as a retreating, natural (pial) surface, as in Fig. 687.

(*b*) Fig. 687. The unaccountable black spot in the center of the middle commissure should be erased; it does not appear in Fig. 801, of part of which Fig. 687 is an enlargement.

(*c*) Wherever they occur *conarium* and *epiphysis* should be replaced by *pinea.* With *medicornu, medicommissure,* and *medipedunculus,* as Angloparonyms of the Latin forms, the prefix should be *mid-*.

5. My paper on "Neural Terms"[9] was prepared under considerable pressure of regular duties and contained many verbal errors. Some of these were specified in the "Additions and Corrections" on p. 352. Such as were detected later were enumerated on a leaflet entitled "Errors and Omissions" dated March 30, 1898. Copies of this leaflet were distributed to recipients of reprints of the paper, and others are at the service of those who have files of the journal in which it appeared. On p. 306 of the paper itself, at number 122, in the first and second columns, "inflecta" should be *inflexa.*

6. Most preserved human fetal cerebrums of the third and fourth months present linear depressions not found at later periods. Like Cunningham and some other anatomists, up to 1903, I regarded these "transitory fissures" as normal, although my brief discussion of them before the Association of American Anatomists[10] contained the query, "Are any of them merely artifacts?" With most of them the non-existence of a corresponding fold of pia should have suggested that explanation. The observations of Retzius, Hochstetter, Mall[11] and G. Elliott Smith[12] upon fresh and unaltered cerebrums showed that they are truly artificial features caused by either post mortem corrugation or the pres-

[7] On the brains of *Amia, Lepidosteus, Acipenser* and *Polyodon. Amer. Asso. Adv. Science, Proceedings,* 1875, pp. 168–194.

[8] *Journal of Comparative Neurology,* Vol. I., pp. 201–203, October, 1891.

[9] "Neural Terms, International and National," *Journal of Comparative Neurology,* VI., December, 1896, pp. 216–352, including seven tables. Parts VII.–IX. have also been reprinted under the title "Table of Neural Terms, with Comments and Bibliography."

[10] *Proceedings,* May, 1894, p. 33.

[11] *Amer. Jour. Anatomy,* Vol. 2, pp. 333–339.

[12] *Anat. Anzeiger,* Vol. 24, pp. 216–220.

sure of membranous folds at the coronal and lambdoidal sutures.

Having now explicitly corrected my own more important errors[13] I venture to point out a few cases in which a similar course might well have been followed by others.

7. In both German and English editions of Wiedersheim's "Comparative Anatomy of Vertebrates," in his "The Structure of Man," and in other works into which it has been copied, is what purports to represent the base of the brain of the rabbit as a representative mammal. One of the constant and peculiar characters of that class is the pons, a mass of obviously transverse fibers at the ventral side of the cerebellum. In this figure the region is marked *pv.*, and the abbreviation is said to stand for "pons Varolii," but the contour and the shading give not the least idea of its essential character; indeed, the mesal furrow is more distinct than in the bird on the opposite page. To the serious and needless misrepresentation attention was called in SCIENCE for May 8, 1908, p. 741.[14]

8. In 1906 was published J. B. Johnston's "The Nervous System of Vertebrates." In January, 1908, his attention was called to the fact that Figs. 2 and 120, said to represent "the mesial surface of the right half of the brain of *Squalus acanthias*" (the acanth or spiny dogfish), must be of the smooth dogfish, *Mustelus*. The latter genus exhibits a decidedly more advanced morphologic stage as to the cerebellum and the cerebral extensions; indeed the two genera are placed by zoologists in not only separate families but different divisions or suborders. In 1909, in a paper[15] by the same author, the figure is reproduced and correctly named; but the statement that it was taken from the earlier work is unaccompanied by any intimation of the original misnomer. Even had it been, students and general readers are more likely to consult the book than the comparatively technical journal, and even instructors are none too familiar with selachian brain forms; the original misnomer was not mentioned in the reviews in SCIENCE, December 28, 1906, in the *Anatomischer Anzeiger*, November 9, or in the *Journal of Comparative Neurology and Psychiatry*, Volume 16, pp. 467–470;[16] hence it would have been more just to others and better for himself if the author had published a prompt and explicit correction in SCIENCE.

9. In 1893 the late Wilhelm His published[17] a figure described as "Medianschnitt eines menschlichen Gehirns vom Erwachsenen." As a mere diagram of general features it might serve the purpose for which it was intended; as purporting to represent a comprehensive, complex, and important aspect of the brain it embodies at least twenty errors or omissions and would not have been accepted from a member of my class in the morphology of the brain at any time during the last twenty years; especially does it fail to indicate the circumscription of the cavities and the demarcation of the artificial (cut) surfaces from the natural ones covered by pia or

[13] For reminders of others that have caused or might cause misapprehension I shall be grateful.

[14] An interval of three years should have sufficed for the replacement of the same faulty figure by a correct one in the recently issued edition of Parker and Haswell's "Textbook of Zoology," Vol. 2, p. 468. This new edition likewise repeats the erroneous designation of the lamprey represented in Fig. 793 (Fig. 749 of the first edition) as *Petromyzon marinus* (sea lamprey) whereas it is *P. fluviatilis* (river lamprey) in the original paper of W. K. Parker, *Philosophical Transactions*, Vol. 74, 1882, plate 8; the arrangement of the teeth is very different in the two species, and the error is sure to cause confusion. T. J. Parker, the senior author of the work, and W. N. Parker, the associate editor of the second edition, are both sons of the author of the paper. Surely the latter would have insisted upon the correction had he been informed of the misnomer, to which the attention of the publishers was called by me at least two years ago.

[15] The morphology of the forebrain vesicle in Vertebrates. *Journal of Comparative Neurology and Psychiatry*, November, 1909, pp. 457–539.

[16] This review did correct the misplacement of Figs. 175 and 177 and of Figs. 176 and 178.

[17] "Vorschlage zur Eintheilung des Gehirns," *Archiv für Anatomie, etc.*, Anat. Abth., pp. 172–179, Fig. 3.

endyma. These defects were pointed out by me in 1899,[18] but in the present paper they are of interest mainly as neither corrected nor even alluded to in any of the reproductions of the figure known to me.

The figure and description are given on p. 876 of the protocols of the committee (of the Anatomische Gesellschaft) on anatomic nomenclature in the fasciculus dated March 20, 1894; these protocols were edited by W. Krause.

But in the following year, in the final report,[19] commonly known as the "B N A," supervised and explained by His himself, the same figure appears on p. 161 as "Mediandurchschnitt durch ein fötales menschliches Gehirn aus dem dritten Monat." It may be conjectured that there had occurred an inadvertent repetition of the legend under the figure on the opposite page (where, however, the first word is "Medianschnitt"); but it is not easy to understand how so self-evident an error could escape the other members of the committee.

With the original correct designation of "adult" the figure was reproduced in 1897 by van Gehuchten (Anatomie du systeme nerveux de l'homme, second edition, Fig. 17), and in 1899 by L. F. Barker (The Nervous System and its Constituent Neurones, Fig. 92).

But in 1901 the identical figure, reduced about one third, was employed by Barker[20] and described as a "Median section through a human fœtal brain of the third month, after His, 1892" [probably 1893 was meant].

[18] Comments upon the mesal [median] aspect of a human brain as published by His and reproduced by him and others. *Asso. Amer. Anatomists, Proceedings*, 1899, pp. 23–24.

[19] "Die anatomische Nomenclatur. Nomina anatomica, Verzeichniss der von der Anatomischen Gesellschaft auf ihrer IX. Versammlung in Basel angenommen Namen. Eingeleitet und im Einverständniss mit dem Redactionsausschuss erlaütert von Wilhelm His." *Archiv für Anatomie und Physiologie*. Anat. Abth., Supplement Band, 1895. O., pp. 180; 27 figs., 2 plates, 1895.

[20] Buck's "Reference Handbook of the Medical Sciences," second edition, Vol. 2, Fig. 939.

Students and lay readers might easily be confused or actually misled by the discrepancies indicated above. As yet no explanation or expression of regret has been encountered by me. Fitting opportunity would seem to have been provided for Professor His in his article on nomenclature in the *Anatomischer Anzeiger*, Vol. XII., October 30, 1896, and for Dr. Barker in his "Anatomical Terminology with special reference to the B N A," 1907.[21]

The injuriousness of an uncorrected error depends not alone upon its intrinsic extent but also upon certain extrinsic conditions, viz., (*a*) the number and status of those who are interested in the subject and therefore liable to be misled; (*b*) the publication in which it appeared; (*c*) the evidence of its unchallenged acceptance by others; (*d*) the number of repetitions; (*e*) the reputation of its originator. To these self-evident propositions should perhaps be added the reminder that one need not himself be inerrant in order to point out imperfections in another.

The desirability of the explicit correction of errors under some circumstances has now, I trust, been indicated by example as well as by precept.

BURT G. WILDER

ITHACA, N. Y.,
April 6, 1911

[21] So far as I know, the "Isthmus rhombencephali" was never withdrawn by Professor His or, explicitly, by any of the several who adopted it; see the papers by B. B. Stroud and the writer, Association American Anatomists, Proceedings, 1899, and SCIENCE, March 16, 1900.

SPECIAL ARTICLES

THE SINGLE CYCLE DEVELOPMENT OF THE GRAND CANYON OF THE COLORADO

SEVERAL years ago Davis[1] called attention to a number of facts which lead him to conclude that the Grand Canyon of the Colorado has been developed in a single cycle of erosion as contrasted with the two cycles postulated

[1] "An Excursion to the Grand Canyon of the Colorado," *Bull. Mus. Comp. Zoology*, Harvard College, XXXVIII., May, 1901.

by Dutton.[2] This conclusion does not appear to have received the attention that it merits, probably because Dutton's monograph has for so long been the accepted source of information concerning the region. But as more recent work has shown, Dutton's conclusions in regard to the history of the Grand Canyon District are subject, in general, to important modifications. The writer would like to emphasize, therefore, some of the data supporting Davis's conclusion as to a single cycle of development as they impressed themselves upon him during a recent revisiting of the canyon after a lapse of several years.

One of the most striking features in the development of the canyon is the perfect correlation that exists between the topography and the different rock formations. This is seen throughout the canyon, but is more easily comprehended in small areas. On a large scale two distinct canyon forms may be noted depending upon the character of the eroded strata. One is the comparatively wide-bottom type which is developed where the strata are soft, as in the Unkar and Chuar area in the vicinity of the mouth of the Little Colorado River. The other is the more common gorge type as developed, for example, in the Kaibab and Toroweap sections of the canyon where the river is cutting the more resistant granite, Tonto and Redwall formations. In any limited view of the canyon walls the relationship is even more impressive; the resistant formations always give rise to cliffs and the softer ones to graded slopes, so that the resulting topography is of wonderful constructive beauty and possesses an almost infinite variety of detail.

Attention may be called particularly to the resistant cliff-making formations and the part they have played in bench-making through the stripping of the overlying soft strata. It may help to visualize the facts here presented if the idea is kept in mind of the Colorado River cutting into the plateau and successively exposing the resistant formations on which benches have been developed by the removal of overlying soft strata; the development and dissection of each bench progressing as the river has cut more deeply into the plateau.

In the Kaibab section of the canyon benches may be seen at several different horizons. There are traces of one at the summit of the upper Aubrey cross-bedded sandstone near the top of the canyon walls. It has probably never been of any extent, since the overlying upper Aubrey cherty limestone is in itself too nearly of the same resistance to be easily stripped off. There are numerous indications of a bench at the summit of a group of heavy sandstone members near the top of the lower Aubrey red sandstone. The upper one third of this formation is, on the whole, more uniformly soft than the lower two thirds and must have been eroded with comparative rapidity. The next bench, a very noticeable one, is situated at the summit of the Redwall formation, which is the most prominent cliff-maker found in the canyon walls. The lowest bench is the Tonto, located immediately above the granite gorge. This bench is the latest one that has been formed and is, therefore, the least dissected.

Throughout there is, then, a striking dependence of the benches upon the character of the strata; they are found at the summits of resistant beds which in all cases are overlain by soft ones. If, therefore, there is any good reason for considering the Tonto bench in the Kaibab section as indicating a base-level of erosion and a halt in the uplift of the region, as is necessary on the assumption of two cycles of development, there is equally good reason for supposing that base-levels of erosion also occurred at the summits of the other resistant formations. It is hardly reasonable, however, to expect such a nice adjustment of base-levels, three or four in number, to such definite structural horizons. It must be concluded, rather, that the benches are simply what they appear to be—the stripped surfaces of resistant formations which have been successively exposed in the progressive down-cutting of the Colorado River through the plateau. Consequently the uplift of the region,

[2] "The Tertiary History of the Grand Canyon District, Arizona," Monogr. II., U. S. G. S., 1882.

on the whole, has been continuous and the erosion of the canyon has been accomplished in a single cycle.

Another fact which eliminates the necessity of considering that the esplanade—Redwall bench—of the Toroweap and the Tonto bench of the Kaibab section represent a common base-level of erosion and a halt in the uplift of the region is that these two benches occur in the same locality one above the other in undisturbed condition and separated vertically by over 1,000 feet. Evidently they can not indicate one base-level of erosion and it is necessary to suppose, as in the previous case, that they represent two base-levels, each coinciding with the summit of a resistant formation, or that the benches are structural surfaces exposed by the removal of soft overlying beds. The latter explanation, taken in connection with other lines of evidence, is to be considered the correct one.

In the foregoing paragraphs it has been assumed that Dutton considered the Tonto bench as equivalent to the esplanade farther west and as indicating a base-level of erosion. It should be said that Dutton does not specifically make this correlation. He states that the esplanade represents a base-level of erosion (p. 121) and in speaking of the first stage of the canyon cutting says that "during this paroxysm of upheaval the outer chasm of the Grand Canyon was cut; the river corrading down to the level of the esplanade in the Kanab and Uinkaret divisions but *below that horizon in the Kaibab*" (p. 226). In speaking of the second stage he says that "the narrow inner gorge of the Toroweap was swiftly cut, and is in this respect *a type of the lower deeps of the entire canyon*" (p. 227). The only lower horizon in the Kaibab which has a development corresponding to the esplanade of the Kanab and Uinkaret sections is the Tonto bench. And the only part of the lower depths of the Kaibab which is comparable with the inner gorge of the Toroweap is the granite gorge. The Tonto bench lies immediately above the granite gorge in the Kaibab, as does the esplanade above the inner gorge of the Toroweap. It has seemed to the writer that the logical interpretation of these statements permitted the correlation of the Tonto bench with the esplanade; but this may be taking too great a liberty with the written word.

A minor topographic detail, of definite import, however, which argues against the Tonto bench being a base-level of erosion and indicating a halt in the uplift of the region, is seen just west of the mouth of Bright Angel Creek. At this locality the Tonto formation has been faulted to the extent of about 400 feet, and the faulting is apparently of pre-Carboniferous date and in any case older than the cutting of the canyon. (The displacement here referred to is not the Bright Angel fault.) The point is that a bench has been perfectly developed at the same horizon in the sandstone, judging from the eroded remnants, on both sides of the fault, notwithstanding the difference in the elevation of the strata in the two blocks. It is evidently unduly complicating matters to suppose that the lower bench, for instance, represents a base-level of erosion and that the upper one originated in some other way, for this is calling in two processes to explain exactly similar things. The true explanation is clearly to be found in the single process of stripping and consequently the Tonto bench in general, like the older benches in the Carboniferous formations, does not indicate a pause in the uplift of the region, but is simply a stripped structural surface exposed by the removal of the softer overlying beds.

The writer has little doubt that when this problem is studied in more detail many other facts will come to light supporting the general conclusion of Davis "that while many partial cycles of erosion may have preceded the long pause during which the broad denudation of the plateaus was completed, only a single uplift and a single down-cutting are recorded in the canyon."

H. H. ROBINSON

THE HUMAN FACE

IT seems surprising how little we are influenced by the scientific method in the ex-

amination of faces. Yet when we inquire into causes and results and learn something of the influences which have modified the facial type, and especially when we consider our individual bias with respect to all the people we see and know, then the difficulties of accurate and general conclusions become evident indeed.

The face of man is distinguished from that of lower animals by the greater development of the frontal region or forehead and the development of folds which delimit the chin. In lower races of mankind the lack of development of the frontal region and bridge of the nose, slight projection and great breadth of the nasal region and the large heavy jaws, are evident.

Early ontogenetic conditions of the human face simulate the lower animals, while later stages suggest the lower races. The arching of the frontal region soon destroys close resemblances to lower types but the broad, bridgeless condition of the nose in the embryo does not so quickly disappear and may indeed persist in the adult. The chin may be receding or almost lacking, a condition also well recognized after birth and throughout life in a considerable proportion of individuals.

In the development of the intellectual value of a face, we can trace a connection between the size of the frontal region of the brain and the height and breadth of the forehead, although judgment of intellectual worth by this criterion can be of only the most general character because of the variation in skeletal structures.

When we try to trace the evolution of the face from an esthetic viewpoint we encounter still greater obstacles. In the first place a definition of beauty is difficult and yet if we examine the faces of ancient Assyria, Egypt and Greece, we find in general the same outlines or much the same features which we now usually regard as beautiful. Aside from this *general* type, we, each one of us, hold certain features or combinations of features to be especially beautiful because of people we have known, or for some other reason. But so far as the general idea of what constitutes a beautiful face is concerned we might, perhaps, find that it must have its parts in good proportions, no single feature should represent the extreme. Each element should bear a certain definite relation to the rest, with the profile lines regular and the curves of a delicate sweep. It should express unity as well as variety.

Why the human face has developed as it has may be due to our ideas of what constitutes beauty, and if we inquire into this a little more closely, the following suggests itself: The earlier ideas of beauty were determined by a comparison with the lower animals, possibly with the ape in the beginning; in part, the antithesis of such a face was first recognized among primitive men as beautiful. That such comparisons are constantly being made by ourselves to the disadvantage of one who seems to resemble a lower animal in appearance, and that such comparisons are also being made by lower races in the savage state, no one who inquires into the subject can doubt. In the case of lower and higher races, those resemblances to the lower are regarded even by primitive people to be less admirable. Of course many primitive tribes often develop one or another idea of beauty which is not coordinate with that found in the higher races.

This principle of antithesis I believe can not account for *all* the perfection of a beautiful ideal, for with the evolution of the race, education along many lines contributes a component, the artistic sense becomes developed and fine lines with delicacy of contour come to be appreciated. These ideals work over the rather rude materials furnished by selection.

There is another most interesting and difficult problem which confronts us in this connection. How may we judge character from the face? What information may we gain of the intelligence, moral worth and disposition of an individual in this way? We are familiar with the often extremely absurd claims of phrenologists and physiognomists, but none of us doubt that an individual's character shows more or less in his face. Yet

when we analyze our methods of determination we find them for the most part based on nothing but vague impressions. Many, if not most of our personal judgments are of this sort; when inquired into they are as absurd and with as little foundation as are the ideas contained in the older works on physiognomy.

There usually has been, as Mantegazza recognizes, a confusion of two separate factors in the determination of character from a face; the mold or cast of the features and their expression. These two are distinct and should be so regarded. Although the latter may in time mold or modify the former to a large degree, many of the parts of the face come very little under its influence, and except for the changes which expression and physiological conditions bring about in the course of time, I am inclined to totally ignore all judgments of character from facial mold alone. As yet it seems to me we have not the least safe evidence for regarding this or that type of eye, nose, mouth or chin as indicating one or another sort of character, only in so far as the life and disposition of the individual has modified them through expression. The one feature which may show something of the character independent of expression has already been mentioned in the forehead, but the bones of the skull and the sinuses within them are so variable that nothing but the most general conclusions can be drawn even here. We often find faces of a low type associated with a defective individual and there may be some relation between defective physical and psychical conditions, but just what the connection is, remains to be learned.

Several of the causes which have led us to consider this or that mold of feature as indicative of special characteristics of the individual are the following:

1. The resemblance to lower animals and the inference that man has the character of the animal in whose face we see a likeness. Much was made of this in the older works upon physiognomy and it becomes absurd when we consider for instance, that one with a face like a lion has the character we ascribe to that beast, or a face like a crow indicates the prying nature so commonly known in pets of this species. Yet are we to-day, generally speaking, much better than this when we ascribe to a man whose face reminds us of a fox, a fox-like nature? Or when a man with a bulldog-like mouth and chin is accredited with a character which savors of this animal's qualities?

2. The resemblance in another of features from one or several individuals whose character we know. Such comparisons are very common. It is difficult to determine how far every one is thus influenced.

3. The fixed resemblance in contour of face or feature to certain transitory expressional states which we have come to associate with emotional conditions.

To many, a long nose gently depressed at the tip indicates a benignant character. This, I think, is because in certain types of noses we have seen the tip slightly depressed in smiling and the long nose with the slight depression gives the appearance of a continued gentle smile, while it may or may not indicate a benignant character, depending upon how much expression has modified the feature.

In case the end of the nose is more flattened, we very often get the idea of a cruel or cynical individual, because in a sneer or grin, the tip is sometimes greatly depressed.

Those in whom the corners of the mouth turn up a little, or in whom the lips are moulded so as to convey that appearance, give us the resemblance to a smile which we associate with cheerfulness. And one in whom the corners of the mouth are formed in such a way as to make them appear to turn down, so much resemble the expression of grief or sorrow that we think of the individual as possessing a melancholy disposition.

Another illustration. Those in whom the eyes are deep under heavy eye brows are said to be thoughtful because during mental concentration we are apt to draw the eye brows down and together. Many other examples might be given.

4. Physiological conditions.

Of course expression is physiological primarily, but more or less separate from its emotional side, there are a number of purely physical conditions either permanent or transitory which influence to a large degree our judgment of character. The appearance of good or ill health and the changes which may take place in a face due to the adaptations of the body to environment. Under the last come such changes as might take place in the nostrils with variation in altitude, in the development of the jaw muscles due to change of food, and many others.

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Cornell University

OCCURRENCE OF EUTHRIPS PYRI DANIEL IN NEW YORK STATE

For several years pear growers in various localities in this state have observed a peculiar blighting of blossoms, which is usually attended by a considerable loss in the fruit yields. In some orchards where this condition has prevailed the crops for the past three years have been almost complete failures. This spring we received specimens of injured blossom clusters from Germantown and other localities along the Hudson River, and we have found that an insect is responsible for this damage. It is known as the pear thrips (*Euthrips pyri* Daniel), and for the determination of the species we are indebted to Dr. W. E. Hinds, of the Alabama Polytechnic Institute. The insect has attracted considerable attention in recent years in California because of its destructiveness to various deciduous fruits, but its occurrence in eastern states was not suspected. The adult is a small, brown, winged insect, about one twentieth of an inch long, which makes its appearance when the buds are opening, attacking the tenderest of the flower parts. Pears, especially, seem to be very susceptible to the attacks of the thrips, and many blossoms are killed before the clusters open. This pest has proved a difficult one to control by spraying, but tests which we have conducted indicate that the thrips may be efficiently combated by slight changes in the scheme of spraying which we are encouraging growers to adopt for the control of the pear psylla.

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New York Agricultural Experiment Station

BLUE STAIN ON LUMBER

Each year a great deal of money is lost by lumber companies through the staining of the freshly cut sap yellow pine and red gum stacked in the mill yards. One of the commonest of these stains is the so-called "blue-stain," which is caused by a number of fungi, many of them belonging to the Pyrenomycetes, especially *Ceratostomella* and *Graphium*. This stain is usually blue or black, due, very likely, to the presence of the brown-colored mycelium which grows in the cells of the sap wood only, and does not injure the strength of the wood. The hyphæ of the fungi live on the food stuff within the wood cells and do not destroy the walls of the cells. It is the stained appearance of the lumber which seriously decreases its money value.

The lumber companies try to prevent this stain by various methods, a common one being to dip the freshly sawed lumber into a solution of either sodium bicarbonate or sodium carbonate. This soda dipping process is still uncertain in results; at one time preventing the blue-stain from appearing on the wood, at another having no beneficial effect.

The varying and often unsatisfactory results obtained in the mill yards where soda dipping has been tried, led to certain investigations being taken up in the laboratory. The problem was to find why the soda solution sometimes prevented the growth of the wood-infecting fungus and its spores and sometimes did not. Since the factors determining the growth of *Ceratostomella* and of *Graphium* are as yet imperfectly understood, it was thought that a better knowledge of the relation of the fungus to its substratum might lead to a more satisfactory method of destroying it.

As it is well known that many fungi grow best on a slightly acid substratum, it was thought that the growth of the blue-stain

fungi might be influenced if not determined by the acidity of the boards.

In order to determine the relation of species of *Ceratostomella* to various quantities of acids and alkalies in the medium upon which they grow, a number of experiments were made with definite additions of acids and alkalies to a medium of known character.

Laboratory Experiments.—A nutrient medium of .5 per cent. Liebig's extract, 1 per cent. malt extract and 2 per cent. agar agar neutralized to phenolphthalein with NaOH was prepared, to which .5, 1, 1.5 and 2 per cent. sodium carbonate c.p. (Na_2CO_3) and .5, 1, 1.5 and 2 per cent. citric acid ($C_6H_8O_7 + H_2O$) were respectively added. To these media and to the neutralized medium the mycelium of actively growing *Ceratostomella echinella* E. & E. was transferred. There was excellent growth on the acid and neutral media, but none on that containing excess sodium carbonate. The spores of *C. echinella* germinated on the media containing .5 per cent. Na_2CO_3, but 1 per cent. Na_2CO_3 inhibited growth.

After this fresh sap boards of yellow pine (*Pinus palustris*) and of red gum (*Liquidambar styraciflua*) were dipped in various solutions of sodium carbonate and of sodium bicarbonate. The boards were inoculated with spores of *Ceratostomella echinella* and then stacked in compartments whose temperature averaged about 77° F. and whose atmosphere was so moist water collected in drops on the sides of the compartments (optimum conditions for blue stain). The result of the experiment is tabulated below. Fungus infection is indicated by +, sterility by 0. The number of boards dipped in a solution varied. There were always two at least.

SAP YELLOW PINE

Inoculated with *Ceratostomella* spores

Dipped in boiling

H_2O +	
1% Na_2CO_3 +	1% $HNaCO_3$ +
3% Na_2CO_3 +	3% $HNaCO_3$ +
5% Na_2CO_3 +	5% $HNaCO_3$ +
7% Na_2CO_3 0	7% $HNaCO_3$ +
8% Na_2CO_3 0	8% $HNaCO_3$ 0
10% Na_2CO_3 + slightly.	10% $HNaCO_3$ + slightly.

Dipped in cold solutions of:

6% Na_2CO_3 +	6% $HNaCO_3$ +
8% Na_2CO_3 +	8% $HNaCO_3$ +
10% Na_2CO_3 +	10% $HNaCO_3$ +
H_2O +	

SAP RED GUM

Inoculated with *Ceratostomella* spores

Dipped in boiling

H_2O +	
1% Na_2CO_3 +	1% $HNaCO_3$ +
3% Na_2CO_3 +	3% $HNaCO_3$ +
5% Na_2CO_3 +	5% $HNaCO_3$ +
7% Na_2CO_3 + slightly.	7% $HNaCO_3$ +
	8% $HNaCO_3$ + slightly
	10% $HNaCO_3$ + slightly.

Dipped in cold solutions of:

3% Na_2CO_3 +	3% $HNaCO_3$ +
5% Na_2CO_3 +	5% $HNaCO_3$ +
	7% $HNaCO_3$ +
H_2O +	

SAP RED GUM

Inoculated with *Ceratostomella* spores

Dipped in

H_2O +

5% H_2SO_4 + 7% H_2SO_4 + } All boards equally infected.

The cold soda solutions were found not to be as effective as the hot solutions. This may have been because the boiling solutions by removing air bubbles came more in contact with the wood fibers, and because they penetrate the wood. According to the laboratory test of the board-dipping process, 7 and 8 per cent. solutions of sodium carbonate and 8 and 10 per cent. of sodium bicarbonate gave the best results. Spores germinated on these boards, but the mycelium did not grow so that it could be seen by the naked eye.

To summarize the results of the laboratory experiments:

Ceratostomella echinella spores germinated on a nutrient agar medium which had been neutralized to phenolphthalein with sodium hydroxide when .5 per cent. sodium carbonate had been added to the medium.

One per cent. sodium carbonate added to the neutralized agar medium did prevent the germination of the spores.

Red gum boards dipped in a 7 per cent.

sulphuric acid solution stained as readily as the controls dipped in water.

Red gum and yellow pine sap boards dipped in a hot 7 and 8 per cent. solution of sodium carbonate and a hot 8 and 10 per cent. solution of sodium bicarbonate did not stain.

After these laboratory experiments, the experiments with the boards was repeated in the field. That with the yellow pine in a lumber yard in Louisiana from which the yellow pine used in the laboratory had been received. The red gum experiments were made in a hardwood mill in Mississippi from which the red gum boards experimented with came. In the field experiments the sodium carbonate used was the commercial soda ash, and the sodium bicarbonate the Thistle Brand Soda.

The tests were as follows:

In a Louisiana lumber yard where the pine boards were staining just where the boards crossed in the open stack, the remainder of the boards clean. Dry weather.

Green yellow pine—

5.3% sodium carbonate 2,184 ft. B.M. dipped.
4% sodium bicarbonate 3,136 ft. B.M. dipped.

The treated lumber was stacked wet one board on top of the other, and held for observation for seventeen days. The boards remained unstained.

In a Mississippi lumber yard where the stacked boards were staining. Rainy weather.

Green red gum—

8% sodium carbonate 3,012 ft. B.M. dipped.
11% sodium bicarbonate 3,000 ft. B.M. dipped.

The treated lumber was stacked wet one board on top of the other, and held for observation fourteen days. Some of the sodium bicarbonate boards were stained in spots. A very few of the boards dipped in sodium carbonate were stained on the ends. It was found that the percentage of alkalinity of the solution in the dipping vat was the same or was a little greater at the end of the "day's run" than at the beginning.

Briefly stated the results of the field experiments were as follows: An 8 per cent. solution of Na_2CO_3 was as effective as 11 per cent. $HNaCO_3$. These soda solutions prevented the blue stain on red gum when the weather was rainy. In dry weather 5 per cent. Na_2CO_3 and 4 per cent. $HNaCO_3$ kept yellow pine boards clean.

In these experiments, laboratory and field, the blue staining fungus showed itself sensitive to alkalies in the medium on which it grew. The amount of alkalies necessary to inhibit the growth of the fungus varied with the substratum. An increase in the acidity of the medium did not prevent fungus growth. Freshly cut red gum and yellow pine sap boards required 8 per cent. Na_2CO_3 or 10 per cent. $HNaCO_3$ to prevent them from being stained when the blue-stain fungi were growing vigorously.

Considering that the blue-stain fungus thrives on a substratum containing a large amount of acid and is sensitive to alkali in the substratum, the acidity of the surface of the boards just after being cut and the vigor in the first growth of the fungus seem correlated. It is probable that a large amount of acid is generated on the surfaces of the sap boards when such strongly alkaline solutions must be used to prevent the blue stain.

This acidity of the boards, greater than has probably been realized, may be the answer to the problem as to why a soda solution of a given strength is not always successful in preventing the blue stain. A weak alkaline solution may be successful in keeping the boards clean when the atmospheric conditions are not favorable to the growth of the fungus; when these conditions favor fungus growth, the soda solution has not sufficiently neutralized the board acids to stop the germination of the spores and their mycelial growth.

A greater resistance to the alkali in the medium was shown by the spores of *Ceratostomella* than by the mycelium. If this is the case with the wood-staining fungi, it is advisable when determining the value of wood-impregnating materials, to test them with the spores of the wood-destroying fungi, not alone with the mycelium as has generally been done hitherto.

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SCIENCE

FRIDAY, JULY 28, 1911

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MECHANISMS OF CELL ACTIVITY[1]

EVERY scientist who concerns himself with the problems of his own specialty must devise for himself certain concrete pictures of the nature of the fundamental units with which his specialty deals, in order that he may have a concrete form in which to clothe his thoughts. Thus each chemist must form for himself some sort of concrete notion concerning fundamentals, like atoms, molecules, chemical affinity, valence and ionization, imagery which he must avoid mistaking for absolute reality, and which he must be ever ready to shift and change and modify, in accordance with the development of chemistry.

The biochemist also has his imagery, only he takes the data of the chemist and physicist as the material out of which he constructs an imagery of his own, dealing not with atoms or molecules as such, but with conceptions of the physical and chemical nature of protoplasm.

I would present to you to-day the hypothesis which some biochemists have developed for themselves concerning the structure of protoplasm and the cell. Such a presentation must be very largely a personal one, for two biochemists would hardly be likely to agree on all the details, however much they might be in accord on the essentials. Consequently, what I am about to offer will contain nothing essentially new.[2]

[1] Address presented before the general meeting of the American Chemical Society at Minneapolis, Minn., December 28, 1910. Published by permission of the Secretary of Agriculture.

[2] For an earlier presentation cf. Hofmeister, Fr., "Die Chemische Organisation der Zelle," Braunschweig, 1901.

My excuse for offering it at all is that it may present views novel to an audience such as this; views that may be of interest because they deal with some of the phenomena of life.

The fundamental unit of the biologist was for many years the cell. The conception of the cell is really an anatomical one, and a mere anatomical consideration of it does not lead to an understanding of its functions. I can illustrate what I mean by discussing the ordinary gravity cell or battery. The anatomist would describe such a cell as consisting of a vessel of some sort of material containing a blue liquid in which there were a whitish mass and a reddish mass at different levels, each connected with a reddish strand projecting upward. Such an analysis is obviously imperfect because it would never lead us to discover that the cell is capable of producing an electric current. However, he who studies the current produced by such a cell, its external and internal resistance, and the like, is, in respect to the gravity cell, a physiologist. Such a physiologist gives us some insight into the functioning of the cell, but he tells us nothing concerning the cause of the generation of the current. The analytical chemist, on the other hand, would tell us that the gravity cell consists of such and such a percentage of silicates, zinc, copper, sulphuric acid and moisture, information very useful in its way, but no more so in the comprehension of cell activity than that furnished by the anatomist and the physiologist. To understand the gravity cell all three kinds of knowledge are essential. Structure counts quite as much as chemical composition. In such instances the chemist needs anatomical knowledge, for with chemical reagents alone one can not recognize structure. Without a knowledge of structure it is often quite as impossible to understand mechanisms as it would be to predict the regular movements of a watch by first smashing it and then determining by analysis that it contains certain percentages of gold, copper, carbon and tin *et al.*[3] Watches may be made of many kinds of material and yet keep the same time. However important the material, it is the structure that is even more essential in measuring time. Apparently this seems equally true of living organisms. The energy moving a watch may be furnished by a spring of brass, rather than of steel. Similarly most living things obtain their energy by the oxidation of carbohydrate, but by no means all. For example, certain kinds of microorganisms, the Beggiatoaceæ, obtain their energy by the oxidation of sulphuretted hydrogen to sulphuric acid. They absorb sulphuretted hydrogen and excrete sulphuric acid. Most living things store up, as reserve sources of energy, some form of carbohydrate, such as starch or glycogen. Not so the Beggiatoaceæ; they store up elemental sulphur. The conclusion is therefore inevitable that for a proper understanding of the mechanisms of the living cell both structural and chemical knowledge is necessary.

Evidently the earlier notions concerning protoplasm were unsatisfactory because they were either purely anatomical or purely chemical, according to the bias of the investigator. Originally protoplasm was regarded as a material showing some anatomical structure, to be sure, but chemically more or less homogeneous, though very complex. The very term "protoplasm," the first formed, is nothing more than a definition of this conception. Later, as biochemistry advanced, protoplasm came

[3] Similar opinions have been expressed, among others, by E. H. Starling ("The Mercers' Company Lecture on the Fluids of the Body," London, 1909).

to be regarded as a very complex though rather homogeneous mixture of materials, some of which were assumed to be alive. The latter were supposed to be huge, complex molecules, protein in the main, but not necessarily entirely so. The vital qualities inherent in protoplasm were supposed to run parallel with the complexity and instability of these huge living molecules. Essentially this was a chemical conception of protoplasm different from ordinary chemical conceptions only in that these hypothetical, hopelessly complex molecules were assumed in some way to possess the power of regenerating themselves when in consequence of their instability they fell to pieces. As we look back now, we can see that apparently the only reason why proteins were chosen to fill this rôle was that at that time far less was known about proteins than about the other constituents of cells. By some it was even imagined that if only it were possible for organic chemists to know the structure of such molecules completely, a deep insight would be gained into the causes of life. Others, less sanguine, believed that this could never be, because in the process of analysis the molecule ceased to live, was changed, depolymerized, so that what was studied had in the very process of study lost its vital properties. Even as recently as the beginning of Emil Fischer's work upon protein the hope was expressed that since he had brought the synthesis of protein within striking distance, a more intimate knowledge of the nature of life would follow. And yet, though it is now possible to make substances very similar to some proteins with very high molecular weights, and though we may rest assured that all the complex substances occurring in living things will eventually be so well known that they will be ranged without wonder and without comment with the vast horde of organic compounds, nevertheless, by such achievements alone, only a limited insight into the mechanisms of life can be gained. The reason is that a study merely of chemical constitution, however necessary, will carry us but a very little way in understanding even the simplest processes which take place in protoplasm, unless it be combined with a study of structure, and of the dynamics resulting from both.

Now when I speak of structure I do not mean necessarily anatomical structure that is visible with the microscope. Still a study of even microscopic structure has been and is of incalculable value. With such studies, the name of Bütschli is indissolubly connected. He it was who first emphasized the fact that protoplasm has the structure of a foam or a network with interstices filled with material of a physical nature different from the network, or finally, the structure of an emulsion. Indeed, his anatomical observations led him to study foams, and emulsions, experimentally, in the hope of being able to interpret his anatomical studies more rationally. His experiments became of fundamental importance in stimulating work in certain fields of pure colloidal chemistry and of the dynamics of surfaces. He understood better than any one before his time the anatomical structure of protoplasm. He was the first to point out that protoplasm is heterogeneous, consisting of at least two phases touching each other by minimal or capillary surfaces.[4] We shall learn to appreciate the great significance of this idea. Even Bütschli, however, found that many heterogeneous systems appeared homogeneous under the highest powers of the microscope, because the differences in refraction between the phases was insufficient to render them visi-

[4] O. Bütschli, "Untersuchungen ueber mikroskopische Schäume und das Protoplasma," Leipzig, 1892.

ble.[5] Visibility depends upon size, differences in refraction, adsorption of stains or reagents and similar more or less accidental phenomena. Plainly there may be physical and chemical structure which does not happen to be visible. It is to such structure dependent upon the heterogeneous nature of protoplasm and to the consequences arising from its nature that I wish to draw your attention to-day.

Protoplasm must have some such organization, other than a merely chemical one. Otherwise we can not understand how so many intricate reactions can take place in an orderly fashion within the narrow confines of a single microscopic cell. Let me illustrate by an example. The yeast cell converts sugar into alcohol, carbonic acid and water. Under certain conditions it also converts sugar into glycogen which it may store for a long time within itself, or which it may soon reconvert into sugar and then into alcohol. Under certain conditions it may oxidize alcohol. It synthesizes protein and cellulose. It forms glycerine, succinic acid and amyl alcohol. It may reduce sulphur to sulphuretted hydrogen. It performs undoubtedly a whole series of cleavages, syntheses, oxidations and reductions, and yet, examined under the microscope, it appears fairly homogeneous. No structure is visible capable of explaining how in this small space so many processes can go on side by side in an orderly fashion without interfering with one another. In a single test-tube it is manifestly impossible. In any homogeneous medium it is manifestly impossible. However, in a heterogeneous medium, such as an emulsion, it is conceivable. We have merely to imagine the reactions as taking place in different phases and to remember that at the points of contact of two phases membranes form. By the term "membrane" we must understand in this connection merely the condensation of material at a surface serving to separate two phases. We have then imagined a structure for protoplasm, part chemical, part physical, sometimes visible, sometimes invisible, in which many reactions might go on side by side as thoroughly separated as though in separate test-tubes. They would, however, go on more effectively than in separate test-tubes, because in these no influence of one reaction upon the other is possible, whereas in a heterogeneous system such an influence between two separated reactions is conceivable. A reaction taking place in one phase, may, either by yielding products soluble in another phase, or by changing concentrations, affect one or two or every other phase. Interrelations of this kind might very well lead to what is ordinarily termed coordination.

[5] Ostwald, Wo., "Grundriss der Kolloidchemie," S. 32, Dresden, 1909.

Indeed, there is some evidence that some of the coordination is of this type. When a piece of protoplasm dies, not all the functions which up to that time it has exercised, cease at once. Some of them may continue for a long time, and these are usually due to enzyme action. In the dying mass respiration may continue as well as many other functions, but while they may be qualitatively the same, quantitatively they differ. The balance present during life is destroyed and certain reactions gain the upper hand, eventually dominating the field till everything else is suppressed. Coordination, the great characteristic of life, disappears. Anything which intermixes protoplasm, hence disturbs the phases, destroys coordination. Freezing is one of the agents exerting this effect upon many forms of protoplasm, for by causing some of the water to crystallize, it most effectively disturbs the balance of the phases. We note this, for instance, in the

freezing of potatoes. Potatoes contain a mechanism for converting starch into sugar. Ordinarily this mechanism is controlled by and coordinated with other mechanisms. Freezing disturbs this balance. The mechanism for the hydrolysis of starch runs riot and the potato becomes sweet. Another instance is the coloration of the leaves in the autumn. Leaves contain among other things chlorophyll, chromogens and an oxidation mechanism. Under ordinary conditions this mechanism is held in check. Frost, however, plasmolyzes the cells, intermixes the protoplasm, and the oxidations run riot. Chlorophyll is bleached so that yellow pigments, such as carotin and xanthophyll, which are ordinarily masked by the green, become evident, while other substances, either preexistent or formed during plasmolysis, are converted into the brilliant pigments of our autumn woods.

Now ever since the processes of life have been studied at all chemically, the ease and efficiency with which protoplasm brings about reactions has filled the chemist with awe. Reactions which he is able to perform *in vitro* only with difficulty by the use of powerful agents and high temperatures, protoplasm brings about perfectly at low temperatures. If we pursue our conception of protoplasm as a heterogeneous system further we can imagine mechanisms by which such action is conceivable.

Many reactions go on rapidly in protoplasm to a high degree of completeness, while *in vitro* the rate may be slow and the yield insignificant. This becomes intelligible in a heterogeneous medium without necessarily resorting each time to the action of an enzyme. We have only to assume that the reaction takes place in one phase and that one or more of the products disappear into another phase as fast as formed. In this way reactions might go on at a rate and to an equilibrium quite different from those *in vitro,* for the products of the reaction would be removed from the seat of reaction almost as fast as formed. Such a mechanism might be merely the result of different solubility in the phases.

A similar line of thought throws light upon the fact that a substance present in protoplasm as a whole, in such minute concentration that *a priori* its influence ought to be negligible, may nevertheless exert a profound effect. We need not necessarily assume that this apparently disproportionate effect is produced by a catalytic mechanism. In a heterogeneous system the concentration of a given constituent as determined by quantitative analysis of the whole may be a spurious value, because this constituent may not be evenly distributed throughout the heterogeneous system. It may be almost absent in one phase and concentrated nearly entirely in another, and this difference in distribution may also be merely the result of difference in solubilities. Hence in protoplasm substances may be concentrated greatly in definite localities and thus make reactions possible which at low concentrations would be infinitely slow.

An uneven distribution of the various constituents of protoplasm such as this, is not the only way in which the concentration may vary according to this multiple phase hypothesis of protoplasmic structure. Even in the same phase the concentration of the substances in that phase may be caused to vary greatly by the energy at work in surfaces. It is a well-known fact that substances which diminish surface tension or the tendency inherent in liquids to assume that shape which reduces the surface to a minimum, accumulate at the surface so that they are present in the thin

surface layer in greater concentration than in the interior. Now in such a system as we have imagined protoplasm to be, the sum of the areas of the surfaces of all the phases must be very great, and consequently the concentration of the various substances distributed through it must vary greatly, not merely according as they are distributed in one or the other phase, but also as they are concentrated still more at the surfaces of one or the other of the phases. This concentration at surfaces may be very great so that the substances are present as though under great pressure, and we must imagine that reactions are facilitated at surfaces just as reactions with gases are facilitated by high pressures. Finally, we can imagine reactions facilitated whenever conditions arise which diminish surface energy, for in that case free energy is produced in the narrow concentrated surface film. How this might facilitate reactions we can only conjecture.

So far we have considered only the grosser phases. Finer phases, however, exist in protoplasm. It is now pretty well established that colloidal solutions are multiple-phase systems. Cells contain colloids in solution, and these colloids usually are of the type known as emulsion colloids, which means that all the phases of the colloidal solution are fluid. We have then here phases of very minute dimension. Now it is well known that the energy acting at surfaces increases relatively with the increase in curvature of the surface. The curvature of these minute colloidal phases is very great, and the energy which acts in these infinitely curved surfaces is correspondingly powerful. It is quite possible that many of the phenomena which are termed enzymotic are brought about by forces of this type, for it is very probable that the class of agents termed enzymes is not a uniform one, but includes many classes of quite different agents acting by as many different mechanisms.

We have seen how considerations of structure have led to conceptions of cell dynamics. Conversely, a consideration of these dynamics can lead us back to a deeper understanding of structure.

Protoplasm ordinarily contains 80 per cent., and upwards, of water. Some beings may contain even more. For example, the medusæ or jelly-fish, fairly firm structures though they are, contain but 3.7–4.6 per cent. of solids.[6] Of these solids over 3 per cent. are the sea salts, so that the bell of the medusa, as solid as a firm jelly, can almost be said to consist of organized seawater. Ordinary protoplasm is not as thin as this. Still of its 15 or 20 per cent. of solids a considerable portion is inorganic salts and other electrolytes, for the greater part in solution, so that they hardly produce solidity. The remaining substances consist of fats, proteins, lipoids and other colloidal material. Built of such materials, it is hard to see how an organism can have so nearly solid or rather semi-solid a structure as protoplasm. If, however, we imagine the materials of which protoplasm is composed as distributed in different phases, the difficulties are not so great. If we imagine the fat and the lipoid as present in a different phase from the water, being present as an emulsion, perhaps rendered permanent by some such substance as soap, and if we think of other substances such as the proteins present in a colloidal and viscous state, and, if we imagine both the crystalloids and the colloids distributed between the various phases, we can get a structure which will be as firm as protoplasm is known to be. Thus it is easy to take egg-albumen, oil and sugar solution and mix them so thoroughly that the re-

[6] Krukenberg, "Ueber den Wassergehalt der Medusen," *Zool. Anzeiger*, 1880, S. 306.

sulting emulsion is firm enough to handle with a shovel. A firm system of this sort is used technically as a lubricant. By the emulsification of certain heavy oils with less than one per cent. of water an emulsion so solid may be formed from the two liquids that it may be whittled with a knife.[7] These considerations, however, do not tell the whole story, at any rate for plants. A part of the firmness of many plant structures is due to the phenomenon termed by plant physiologists "turgor." This phenomenon has much similarity to the inflation of a flabby, hollow, elastic balloon with gas. In turgor, however, the inflation is by water, not gas, and the inflating force is not mechanical but osmotic. How far turgor is responsible for rigidity in animal structures is not yet clear. Certainly something very similar exists in the red blood corpuscles.

We have been considering the concentration of substances upon surfaces of finely subdivided phases; but in obedience to the same laws concentration takes place upon larger surfaces. This phenomenon must occur not merely at the contact surfaces between the phases in the interior, but also upon the outer surface of the protoplasmic mass itself. In such places we must have a concentration of material. Indeed, it can be shown experimentally that many solutions form really quite firm membranes even when there is no chance for evaporation to take place.[8] Very probably this phenomenon is responsible in many instances for the formation of biological membranes and may also account for the differentiation of the external layer so frequently seen in cells. This might merely be the result of the concentration of material in the outside layer in consequence of surface action.[9] Considerable evidence for the participation of surface forces in cell-membrane formation may be found in the studies on hemolysis, by which is meant the leaking of hæmoglobin through the membranes of blood corpuscles. Many of the substances which cause the cell membranes of the red blood corpuscles to lose their semi-permeability in this way, have a great influence on surface tension. Such are soaps and saponine. One of the actions of certain snake venoms is dependent upon the presence in the venom of a substance of this type.[10]

If this hypothesis of concentration of material at the cell surface be correct, then it is easy to understand how many cells have the power of regenerating a new membrane on a wound surface, such as is formed when an amœba is cut in two. The surface energies must begin at once to act at the new surface until it, too, has been brought into equilibrium with the interior just like the rest of the cell surface.[11]

This hypothesis of membrane formation can not be applied, for the present, at any rate, to many specialized membranes such

[7] Ostwald, Wo., *op. cit.*, p. 105.

[8] Ramsden, W., "Abscheidung fester Körper in den Oberflächenschichten von Lösungen und 'Suspensionen'" (Beobachtungen uber Oberflächenhäutchen, Emulsionen und mechanische Koagulation), *Zeitschrift für physikalische Chemie*, Bd. 47, S. 336.

Metcalf, M. V., "Ueber feste Peptonhäutchen auf einer Wasserfläche und die Ursache Ihrer Entstehung," *ibid.*, Bd. 52, S. 1.

Zangger, H., "Die Immunitäts-Reaktionen als physikalisches spez. als Colloid-Phänomen," *Vierteljahreschrift der Naturforschenden Gesellschaft in Zürich*, Jahrgang 35, S. 441.

[9] Overton, E., "Ueber den Mechanismus der Resorption und der Sekretion in W. Nagel's 'Handbuch der Physiologie des Menschen,'" Band II., Teil II., Seite 805–6.

Pfeffer, W., "Osmotische Untersuchungen, Studien zur Zellmechanik," S. 124, Leipzig, 1877.

[10] Zangger, H., "Ueber Membranen und Membranfunktionen," *Ergebnisse der Physiologie*, Bd. 7, S. 138, 1908.

[11] Cf. Overton, *op. cit.*; Pfeffer, *op. cit.*, and Zangger, *op. cit.*

as are found in many plant cells and in the red blood corpuscles. Still surface forces may be concerned even in these morphologically distinct and permanent structures. Now colloidal substances are among those which tend to accumulate at surfaces. Many of them are easily coagulated, and changed in such a way that they become more or less permanently insoluble. Such colloids are said to be irreversible, because after having been put out of solution, they can not easily be made to revert into solution again. Irreversible colloids when they become concentrated at a surface tend to become coagulated. In this way membranes of a high degree of tensile strength and permanency may be made experimentally.[12] Something of the sort might very well occur in cells with a morphologically distinct cell wall.

Of the composition of cell membranes we have in the last decade achieved certain definite notions. The cell membrane is usually semi-permeable, only allowing certain substances to penetrate into the cell. Now there are a number of ways in which the semi-permeability of a membrane may be explained. One is that the penetrating substance dissolves in the membrane. Another is that it combines loosely with it. So if we note what substances penetrate into cells and what the solubilities of these substances are, we may be able to reach certain conclusions concerning the nature of the cell-membrane. This has been done and it has been shown that many of the substances which enter cells are very much more readily soluble in fats and lipoids than in water. Indeed, the narcotic effect upon cells of many indifferent substances is proportionate to their partition coefficient between water and oil. For apparently the same reasons free alkaloids which are soluble in oil seem to penetrate cells, whereas their salts only do so in so far as they are dissociated. For similar reasons undoubtedly the toxicity of certain metallic salts, such as the chlorides of copper and of mercury, is due in part to the fact that, being soluble in organic solvents, they enter cells rapidly.

The objection has been raised to the hypothesis of the lipoid nature of the cell wall that it does not explain how certain substances like sugar, protein and inorganic salts which are all undoubtedly utilized by the cell in one form or another enter the cell. It has, therefore, been suggested that the cell wall has a mosaic structure, other material besides lipoids entering into its composition.[13] This is very probably true, for if we are right in assuming that forces acting at surfaces take part in the formation of the cell wall, then all those substances which are present in the cell, and which have the property of diminishing the surface tension of water, will affect one another in regard to their concentration at surfaces. It is the same phenomenon that has been so much studied in the influence of one substance upon another in respect to adsorption upon solid surfaces.[14] How different substances may influence the concentration of one another on surfaces such as those of cells we can as yet only conjecture, but it is entirely possible that the result may be a mosaic structure of the membrane. If this suggestion prove true, it is possible that protein takes part in the structure. It may be then responsible for the entrance in small amounts into cells of certain substances as required by the metabolism. Proteins, in their capacity as amphoteric electrolytes

[12] Metcalf, M. V., *op. cit.*

[13] Cf. Macallum, A. B., "Cellular Osmosis and Heredity," *Transactions of the Royal Society of Canada*, 3d Ser., Vol. 2, pp. 152 et seq., 1908.

[14] Michaelis, L., "Dynamik der Oberflächen," S. 25, Dresden, 1909.

combine with salts.[15] Indeed it is virtually impossible to prepare protein free from ash.[16] It may be that salts enter protoplasm by combining with protein in the membrane. Even if this mechanism prove ultimately not to exist, all the possibilities are not exhausted. The lipoids, kephalin and lecithin, occur in combination with potassium and sodium.[17] These compounds are freely soluble in anhydrous ether. The metal is not completely masked, but can become to a slight degree dissociated: Perhaps it is by forming such compounds that metals enter cells.

I hope I have shown that by the methods of the organic chemist alone we can not hope to achieve much insight into the mechanisms of protoplasm. These mechanisms are dependent upon structure and this organic chemistry is not capable of revealing. The mechanisms are themselves interrelated and coordinated. These relations and coordinations are not capable of study by the usual analytical methods. The process of analysis destroys them as it destroys life itself of which they are the most characteristic manifestations. These characteristics of life can be approached only from the basis of structure of some sort. For a proper understanding of it, anatomical, chemical and physical knowledge must be combined. The resultant alone offers the hope of widening our knowledge of the mechanisms of cell activity.

CARL L. ALSBERG

[15] Cf. Mathews, A. P., "A Contribution to the General Principles of the Pharmacodynamics of Salts and Drugs," "Biological Studies of the Pupils of W. T. Sedgwick," pp. 103–4, Boston, 1906.

[16] Harnack's ashless protein is really a protein with volatile ash—HCl. *Berichte der deutschen Chemischen Gesellschaft*, Bd. 23, S. 3745, 1890.

[17] Koch, W., and Pike, F. H., "The Relation of the Phosphatids to the Sodium and Potassium of the Neuron," *The Journal of Pharmacology and Experimental Therapeutics*, Vol. 2, p. 245.

THE TOTAL SOLAR ECLIPSE OF APRIL 28, 1911

[PRELIMINARY COMMUNICATION]

ON the way to meet the *Carnegie* at Colombo, Ceylon, I was so fortunate as to make immediate connection at Suva, Fiji, for Apia, Samoa, by means of a small steamer, the *Dorrigo,* chartered by the German government to carry the mail. I journeyed next to Pago Pago, Tutuila, 80 miles distant from Apia, chartering a 30-ton motor boat and arriving at Pago Pago on Monday, April 24. Laying my plans before his excellency, the governor of Tutuila, Samoa, he very courteously put at my disposal the U. S. cruiser, the *Annapolis,* and furthermore gave me the assistance of some of his best officers and men.

When I left Washington on March 16 the possibility of getting into the belt of totality in time seemed too small to warrant taking with me skilled assistants or elaborate outfits for chance eclipse observations. However, I took two magnetometers and Mr. Abbott, of the Smithsonian Institution, kindly provided an improvised hand-driven, double-lens camera of about 11½-foot focus; everything was packed in water-tight cases so as to be prepared for difficult landings. I decided, namely, to get, if possible, on one of the islands not occupied by any eclipse party which, while equally desirable, were not as accessible as the Tongas where all the parties congregated.

The *Annapolis* left Pago Pago, Tuesday night, April 25, and arrived at Tau Island—the nearest accessible island in the belt—the following afternoon. The entire outfit was landed without mishap through the breakers on the northwest side of the island, near the village of Tau; this part of the work was entrusted to Capt. Steffany, a well-known pilot in these waters. By the time the instruments were unpacked and assembled and suitable sites chosen, night came on. We were comfortably quartered in Vaitupu's house, the widow of Tuimanua, who died a couple of years ago and who, during his time, was the most powerful king of the Apanua group.

She, as well as the Samoan chiefs and the natives, showed us every possible courtesy and hospitability and evinced great interest in the success of our work. The party was entertained by the "village fathers" at a native feast and Vaitupu gave a siwa in our honor.

Thursday, the day before the eclipse, unfortunately, was cloudy and showery and our preparations were greatly retarded in consequence. As my chief object was to ascertain whether there might be any possible magnetic effect during the eclipse, I had to pay prime attention to the magnetic observations and to the training of an assistant, Quartermaster Urle, of the *Annapolis,* for taking readings of the magnetic declination every minute for about five hours on the day of the eclipse.

I was fortunate in being able to turn the charge of the photographic work over to Lieut. McDowell, U. S. N., in command of the *Annapolis;* he was assisted by Messrs. Reed and Steffany, also by Dr. Connor and Chaplain Pierce—all of the *Annapolis.* I made the necessary calculations for the orientation of the camera and laid out the necessary lines for guidance in the placing of the camera. Owing to the inclement weather the day before, it was not possible to get the camera finally mounted and in proper position until shortly before totality. The day of eclipse was fortunately clear throughout. There was no opportunity for trying out the finding telescope and slow motion screws in declination and right ascension.

Just before totality, Lieut. McDowell found that he could not use the finder and so rigged up a hastily constructed sighting device for keeping the sun's image centered on the plates and eliminating the diurnal motion. Two exposures of 15 seconds and two of 1 m. 10 s. were obtained. When the plates were developed, it was found that the improvised sighting device had not been wholly successful and so the photographs exhibit effects due to diurnal motion. Apart, however, from these defects, the photographs show clearly not only the inner corona but also most interesting details and coronal extensions reaching out over one half of the sun's diameter. The present corona thus fulfilled the expectations of great development during a sun-spot minimum.

The mean duration of totality, as observed at shore by Lieut. McDowell and Dr. Connor, and aboard the *Annapolis* by Lieut. Baker, U. S. N., was 2 m. 1 s. The great coronal extensions which were chiefly in the sun's southwestern and northeastern edges were not seen visually, for some reason, by any member of the shore party nor by the party aboard the *Annapolis* anchored a few miles distant, in Faleasau Bay. They were, however, seen by two observers to my knowledge, in the Tongas, viz., Capt. Holford on board the *Tofua* and by Mrs. Clement Wragge, who with her husband, the well-known meteorologist, was located near Hapaii, Id.

It is greatly to be regretted that the better equipped and specially trained astronomical parties at Vavau, Tonga, were not blessed with the singular good fortune which befell us at Tau Island. For our prime work—magnetic—it would not have mattered had the weather been bad.

According to special arrangement magnetic observations simultaneous with ours at Tau were made at the five coast and geodetic survey magnetic observatories, also at Melbourne, Christchurch and Apia, where quick-run magnetograms were obtained for five hours. Until the records have been received from stations over the entire globe, it will not be possible to determine definitely whether or not the present eclipse was accompanied by any minute and temporary change in the earth's magnetism.

L. A. Bauer

The Carnegie,
Colombo, Ceylon,
June 21, 1911

SAMUEL CALVIN

Some weeks ago there appeared in Science a brief notice of the death, on April 17, of Professor Samuel Calvin, head of the department of geology in the University of Iowa, and state geologist of Iowa.

Samuel Calvin was born in Wigtonshire, Scotland, February 2, 1840. He came with his parents to America when he was eleven years of age. For three years the family lived on a farm in the state of New York, then they came to Iowa, where from that time until his death Samuel Calvin made his home.

He received his college education at Lenox College, Ia. When he was twenty-four years old he enlisted in the army and served for a few months in the civil war. After returning from the war, he was for four years a teacher of science in Lenox College. He resigned this position to go to Dubuque, where, for seven years, he was principal of a ward school. In 1874 he was elected to a professorship of natural science in the University of Iowa. Here, at first, he had charge of botany, zoology, geology and physiology. Later, he was made professor of geology, a position which he filled with distinction until his death.

He received from Cornell College the degrees of M.A. and LL.D., and from Lenox College the degree of Ph.D.

In the year 1865 he married Louise Jackson, of Hopkinton, Ia. She, a son and a daughter survive him.

In the year 1892 Dr. Calvin was elected state geologist of Iowa. This position he resigned in 1904 owing to the stress of other duties. However, in 1906, upon the resignation of Professor Wilder, he was again elected state geologist and continued to serve until his death. The Iowa Geological Survey under his directorship published about twenty volumes of reports dealing with the geology and mineral resources of the state. Of great scientific value have been his own contributions to the geology of Iowa, especially those papers which have added to our knowledge of the Pleistocene. His most recent scientific publications, which deal with the Aftonian mammalian fauna have done much to unravel some of the difficult problems of Pleistocene paleontology. In all his scientific work he was thorough, no details were considered trivial—his one desire was to discover truth—to find any facts which could make knowledge clearer, broader, more definite. That he had the power to clothe his thoughts in beautiful language is clearly shown in all his writings.

Professor Calvin was a great teacher and his students loved him. His simplicity, his gentleness, his love of justice and truth, his intolerance of deceit and sham, his deep sympathy, his high regard for religion, his lofty ideals of life—these were the characteristics by which he influenced the lives of those who had the privilege of knowing him. Only such a man as he could have given expression to the following tribute to noble manhood:

> Wherever noble deeds are done for truth and right; wherever weak, despairing, fainting, faltering men and women need encouragement to take up heroically the burdens and duties of life; wherever sorrow yearns for sympathy and consolation, or sickness creates necessity for tender ministrations, where the pestilence walketh in darkness; where sin, foul and loathsome, waits for victims; where overpowering temptation saps the foundations of the better will and weaves inextricable toils; wherever, indeed, many-sided humanity calls for help, there will you find some messenger of truth, forgetting self, filled with zeal for God and fellowmen, lifting, helping, encouraging, consoling; pointing out the path of wisdom and the path of peace; illustrating the importance of right living, and leading all to the true appreciation of the beauty of holiness. Such is the noble side of human nature, such is the grand side.

In the death of Samuel Calvin the nation has lost a distinguished scholar, an inspiring teacher and a true and noble man.

GEORGE F. KAY

STATE UNIVERSITY OF IOWA

SCIENTIFIC NOTES AND NEWS

PROFESSOR W. JOHANNSEN, of the University of Copenhagen, whose recent work on heredity and pure lines has attracted much attention, is to give in October and November a course of lectures and seminar conferences on "Modern Conceptions of Heredity" at Columbia University, under the joint auspices of the departments of botany and zoology. Four public lectures will be given on the afternoons of October 13, 20, 27 and November 3, and

these will be supplemented by a series of about eight more technical seminars. The lectures, open to the general public, will give an outline of modern inquiries into the problems of genetics. The seminar meetings are intended for a limited group of investigators and advanced students, and will give opportunity for more critical and informal discussions of special researches in this field. A more detailed announcement will be made by the secretary of Columbia University toward the opening of the academic year.

Among those on whom the University of Birmingham conferred the honorary degree of LL.D. on the occasion of the annual meeting of the British Medical Association, which opened in Birmingham on July 21, are the following: Sir Francis Lovell, president of the Tropical Medicine Section; Dr. R. H. Chittenden, professor of physiology at Yale University; Professor H. Oppenheim, neurologist of Berlin; Professor Paul Strassman, assistant professor of obstetrics, Berlin; Dr. Byron Bramwell, president Royal College of Physicians, Edinburgh; Dr. J. A. Macdonald, chairman of council, British Medical Association; Dr. R. A. Reeve, ex-president British Medical Association and professor of ophthalmology at Toronto; Professor Sims Woodhead, professor of pathology at Cambridge.

The Leipzig Seismological Society has awarded its gold Eduard Vogel medal to Dr. L. Schultze, of Jena.

Dr. T. C. Mendenhall, emeritus professor of physics in Ohio State University and formerly president of the Worcester Polytechnic Institute, has returned to the United States after a long trip abroad and a trip around the world.

Dr. Lester F. Ward, who is giving a course of lectures in the summer session at Columbia University, will sail for Norway on August 17 as a delegate of Brown University to the centennial celebration of the University of Christiania. From there he will go to Hamburg to attend the Congress of Monists which meets there September 8. He will remain abroad until October in order to attend the Congress of the International Institute of Sociology at Rome, before which he is to read two papers on "Social Progress."

Mr. Donald F. MacDonald, geologist to the Isthmian Canal Commission, formerly with the U. S. Geological Survey, has just returned to his headquarters at Culebra, Canal Zone, from a month's professional visit to Costa Rica. While there he made some collections of Tertiary fossils, which will be sent to the National Museum, and visited the Abangarez and Boston groups of mines on the Pacific slope of the Costa Rican Cordillera.

Mr. Floyd W. Robinson, formerly state analyst of the Michigan Dairy Food Department, who testified in the benzoate of soda case in the Federal Court at Indianapolis that benzoate of soda is a harmful preservative and that its use should be prohibited by law, has been dismissed as an employee of the United States Bureau of Chemistry "for the good of the service." Mr. Robinson protests against being dismissed without having an opportunity to know what charges are brought against him.

Professor James Franklin Collins has resigned as assistant professor of botany and curator of the herbarium at Brown University to accept a position as forest pathologist in the Bureau of Plant Industry.

Professor T. D. Beckwith, bacteriologist and plant pathologist at North Dakota Agricultural College and Experiment Station, has been elected head of the department of bacteriology at Oregon Agricultural College and state bacteriologist for the Experiment Station. He will take up his duties at Corvallis, Ore., on September first.

The Royal Society has awarded the Mackennon studentships for the ensuing year to Mr. T. F. Winmill, of Magdalen College, Oxford, for research in structural chemistry, and to Mr. T. Goodey, of Rothamsted Experimental Station, for research on protozoa in relation to the fertility of soil. The Joule studentship for the ensuing period of two years has been awarded to Mr. Albert Eagle, Imperial College of Science, for research on

the thermal relations of spectra of gases and on cognate subjects.

We learn from *The Observatory* that Mr. T. F. Claxton, late director of the Royal Alfred Observatory, Mauritius, has been appointed director of the British Colonial Observatory at Hongkong. Dr. Doberck retired from the directorship of the Hongkong Observatory in 1907, and was succeeded by Mr. F. G. Figg. Mr. Claxton was appointed first assistant at Mauritius in December, 1895, and succeeded to the directorship on the retirement of Dr. Meldrum at the end of 1896.

The International Commission on the Teaching of Mathematics will hold its meeting this year at Milan, September 18–20, under the presidency of Professor F. Klein.

Dr. William R. Brooks, director of the Smith Observatory and professor of astronomy at Hobart College, Geneva, N. Y., discovered a comet on the night of July 20. Its position at 15 hours G. M. T. being R. A. 22 hours, 13 minutes and 40 seconds; declination north 20 degrees 57 minutes. Motion slow northwest. The comet is a fairly bright telescopic object in a 10¼ refractor, and is visible in the 3-inch finder.

Col. M. F. Ward, F.R.S., of Slough, writes to *The Observatory* that the church of that parish has lately been enlarged, but that funds are needed to complete the building by the addition of a tower and spire. He thinks that as Sir William Herschel's large telescope stood within 100 yards of the existing church astronomers might like to erect this spire to the memory of the celebrated observer.

Among eighteen civil list pensions granted by the British government during the past year are the following: Lady Huggins, in consideration of the services to science rendered by her, in collaboration with her husband, the late Sir William Huggins, O.M., £100. Mrs. Sharpe and her daughters, in consideration of the valuable contributions to ornithology made by Dr. Richard Bowdler Sharpe, and of their straitened circumstances, £90. Mrs. Conder, in consideration of the important services rendered to geographical knowledge by her husband, the late Colonel Claude Reignier Conder, and of her inadequate means of support, £75. Mrs. Fysh, in consideration of the services to chemical and physical science of her father, the late Dr. George Gore, F.R.S., and of the circumstances in which she has been placed by his disposal of his fortune for the furtherance of science, £50. Miss Fanny Hind, Miss Flora Hind and Miss Emma Hind, in consideration of the services of their father, the late Dr. John Russell Hind, F.R.S., superintendent of the Nautical Almanac Office, to the science of astronomy, and of their straitened circumstances, £60. Dr. Charles Creighton, M.D., in consideration of his medical and biological researches, and of his inadequate means of support, in addition to his existing pension, £45. Mr. Thomas Whittaker, in consideration of his philosophical writings, in addition to his existing pension, £30.

Mrs. Helena B. Walcott, wife of Dr. Charles D. Walcott, formerly director of the United States Geological Survey, now secretary of the Smithsonian Institution, was instantly killed in the railway wreck at Bridgeport, Conn., on July 11. A correspondent writes: "Mrs. Walcott had been ardently and actively interested in the scientific work of her husband. In 1888 she accompanied him to Newfoundland where they worked out together the key to the succession of the Cambrian formations of the North American continent. They then crossed to Wales and studied the classical Cambrian sections. For eighteen seasons she accompanied Mr. Walcott on his expeditions in connection with geological researches in various regions of eastern and western United States and Canada. She was a most energetic collector, and was at all times an enthusiastic assistant in the scientific activities in which Mr. Walcott was engaged. Since Mr. Walcott's appointment as secretary of the Smithsonian Institution, she had been greatly interested in the development of the United States National Museum and in the general study of museum systems. She was planning to take a still more active part during the coming winter in

the social side of the scientific life of the capital. Possessed of unusual charm of person and manner, Mrs. Walcott's death is a heavy blow to a large circle of admiring friends and acquaintances."

THE death is announced of Edward P. North, a civil engineer of New York City, known for his work in municipal engineering.

MR. RALPH L. BROADBENT, assistant curator in the geological museum of Canada, died at Ottawa, on July 15, aged fifty-two years.

DR. FRANZ KRAHL, professor of bacteriology in the Technical School at Prague, has died at the age of sixty-five years.

THE formal opening of the Panama National Institute, established by the Republic of Panama, took place on June 18 amidst great pomp. The group of buildings forming the institute has been arranged and constructed after the plans of the University of Paris at a total cost exceeding one million dollars. The statues in bronze and white marble of Carrara and the luxurious display of historical oil paintings and medallions on the ceilings and walls of the main building cost over $150,000. The four scattered buildings previously occupied by the colleges of the institute will be converted into Trade and High Schools.

THE *Carnegie* left Cape Town on April 26 and arrived at Colombo on June 9. Important errors in the magnetic charts of the Indian Ocean were found.

WE learn from the *Bulletin* of the American Mathematical Society that a Spanish mathematical society has been organized at Madrid, where its first meeting was held on April 5. J. Echegaray was elected president. The society will publish a *Bulletin* which will be in charge of C. J. Rudea, L. O. deToledo, A. Krahe and J. R. Pastor.

THE junior class in mining engineering at Case School of Applied Science, Cleveland, O., spent the month of June on an inspection trip through the west. Two weeks each were spent in Colorado and Utah. The instructors in charge of the party were Dr. A. W. Smith, professor of metallurgy; Dr. Frank R. Van Horn, professor of geology and mineralogy, and Mr. L. O. Howard, instructor in mining and milling.

ONE of the most lofty mountain regions of the Appalachian system, recently surveyed by the United States Geological Survey, is depicted in detail in a topographic map which the Survey has just published—the map of the "Abingdon quadrangle." This map is on the scale of approximately two miles to the inch and shows an area of a little over 1,000 square miles, embracing portions of southwestern Virginia, northeastern Tennessee and northwestern North Carolina, the three states cornering in the southern part of the quadrangle. The topographic maps of the Geological Survey portray all the works of man as well as the physical characteristics of the country, and the Abingdon map indicates a region of great diversity. Part of the area is seen to be somewhat thickly dotted with villages, settlements and individual farm houses; other portions are shown as vast stretches of high mountain ranges with many lofty ridges, peaks and knobs, devoid of habitations. The larger portion of the quadrangle was surveyed by Topographer Duncan Hannegan, but other topographers who worked on the map are J. D. Forster, R. W. Berry, C. C. Gardner, R. A. Kiger and H. W. Peabody. Hundreds of miles of area were tramped over by these surveyors and scores of camps were established, thousands of sights made and hundreds of miles of level lines run. Thirty-nine indestructible iron bench marks were established, showing the elevations above sea level to the nearest foot. The line between Virginia and Tennessee, as shown on the map, was the subject of much controversy for many years. Recently, however, it was resurveyed, and it can now be easily followed by the monuments which have been placed at prominent places and by the cutting of the timber along the line. The line between Virginia and North Carolina, according to Mr. Hannegan, is of ancient date and is very difficult to follow; many of the inhabitants living close to the boundary are in doubt whether they should pay their taxes in one state or the other, as

there are no monuments, and marked trees are very scarce.

IN Bulletin 401 of the United States Geological Survey, entitled "Relations between Local Magnetic Disturbances and the Genesis of Petroleum," by George F. Becker, the condition of knowledge with reference to the origin of petroleum and other bituminous substances is reviewed. Some oils, says Mr. Becker, are undoubtedly organic and some are beyond question inorganic. They may have been derived from carbonaceous matter of vegetable or animal origin, and they may have been derived from carbides of iron or other metals. It is also barely possible that the hydrocarbons exist as such in the mass of the earth. While studying the subject, Mr. Becker was led to inquire whether any relation could be detected between the behavior of the compass needle and the distribution of hydrocarbons. Not much could be expected from a comparison of these phenomena, for magnetite exerts an attraction on the needle whether this ore occurs in solid masses or is disseminated in massive rocks; moreover, many volcanic rocks possess polarity. In glancing over a map of the magnetic declination in the United States Mr. Becker found that the irregularities of the curves of equal declination of the compass were strongly marked in the principal oil regions. The most marked agreement is found through the great Appalachian oil field, which is the area of greatest variation in declination. In California, also, strong deflections accompany the chain of hydrocarbon deposits. These observations are to some extent also supported by conditions in the Caucasus, where great magnetic disturbances exist. While the theory of the inorganic origin of the hydrocarbons is not proved by this study, yet the contention that great oil deposits are generated from iron carbides is strongly borne out by a study of the map of magnetic disturbances in the United States. The map shows that petroleum is intimately associated with magnetic disturbances similar to those arising from the neighborhood of substances possessing sensible magnetic properties, such as iron, nickel, cobalt and magnetite.

THE Journal of the American Medical Association states that under the supervision of the health department of the Canadian conservation commission, Canada is to have established in the immediate future, a national laboratory for the manufacture of sera, vaccines, toxins and antitoxins. A subcommittee of the federal cabinet has approved of the proposal and has recommended speedy provision for the construction and equipment of the laboratory. This proposition has been endorsed by the Canadian Medical Association at several of its recent meetings.

We learn from *Nature* that a conference was held recently in the zoological laboratory of the University of Utrecht for the purpose of founding an International Embryological Institute. Austria, Belgium, England, France, Germany and Holland were represented at the meeting by workers in the domain of vertebrate embryology; and letters were received from Switzerland and the United States in support of the scheme adumbrated by the conveners of the meeting. Professor R. Bonnet, of Bonn, was elected first president of the institute, and it was decided that the first aims of the new institution should be (1) the collection of complete series of well-preserved embryos of every mammalian order, and (2) a more intimate cooperation between embryologists, for the purpose of attaining a uniformity in nomenclature and the solution of the special difficulties in this field of investigation.

"THE Production of Fuller's Earth," by Jefferson Middleton, of the U. S. Geological Survey, has been published as an advance chapter from "Mineral Resources of the United States, 1910." The fuller's earth resources of the United States, says Mr. Middleton, have attracted considerable attention for several years because of the increasing demand for this material for use as a clarifying agent for mineral and vegetable oils. The original use from which it derives its name, the fulling of cloth, is now of minor impor-

tance. For a great many years fuller's earth was imported from England, the only known source of supply, but in 1893 it was by accident discovered in this country. At Quincy, Fla., an effort was made, without success, to burn brick on the property of the Owl Cigar Company. An Alsatian cigar maker employed by the company called attention to the close resemblance of this clay to the German fuller's earth. As a result of this suggestion, the clay was tested and found to be fuller's earth, and the industry was developed. The principal use of fuller's earth in this country is in bleaching, clarifying, or filtering of fats, greases and oils. The common practise with mineral oils is to dry the earth carefully after it has been finely ground, and run it into long cylinders, through which the crude black mineral oils are allowed to percolate very slowly. As a result, the oil that first comes out is perfectly water white and much thinner than that which follows. The oil is allowed to continue percolating through the earth until the color reaches a certain maximum shade. Then the fuller's earth itself is clarified by a steaming process and used over again. With vegetable oils, however, the process is radically different. The oil is heated beyond the boiling point of water in large tanks, from 5 to 10 per cent. of its weight of fuller's earth is added, and the mixture is vigorously stirred and then filtered off through bag filters. The coloring matter remains with the earth, the filtered oil being of a very pale straw color. American fuller's earths are better adapted than the English earths for use on mineral oils, but the English earths are superior for the treatment of fats and vegetable oils. In clarifying vegetable and animal fats with American earths a more or less disagreeable taste is left—just why has never been determined. To show the growth of the American industry it is only necessary to state that from 6,900 tons in 1895 the production increased to 33,486 tons in 1909. This was the maximum, the output for 1910 being 664 tons less. Florida was the leading producing state in 1910, furnishing 57.38 per cent. of the total output. The other producing states, named in the order of their rank in output and value in 1910, were Georgia, Arkansas, Texas, California, Massachusetts, South Carolina and Colorado.

UNIVERSITY AND EDUCATIONAL NEWS

SIR WILLIAM MACDONALD has completed a large purchase of land on the slope of the mountain adjoining Mountroyal Park and will give the property to McGill University. A new campus and residential buildings will be established upon it. The purchase price was over $1,000,000. Including the cost of Macdonald College and its endowment, this brings Sir William Macdonald's total gifts to McGill University to $10,000,000.

THE New York legislature has passed a bill to appropriate $10,000 for the establishment of a school of sanitary science and public health at Cornell University.

MR. R. C. FORSTER has made a further gift of £30,000 to the fund for providing new chemical laboratories at University College, London.

AT Cornell University Dr. D. C. Gillespie has been appointed assistant professor of mathematics. Mr. G. W. Nasmyth has been appointed instructor in physics and Mr. J. Mackenzie instructor in economic geology.

DR. ELLIOT R. DOWNING, in charge of the department of biology of the Northern State Normal School, Marquette, Mich., has been appointed assistant professor of natural history in the school of education of the University of Chicago.

DR. THOMAS L. PORTER, who has been assistant in physics in Northwestern University and Clark University, has been appointed professor of physics in Colorado College.

DR. BENJAMIN F. LOVELACE, professor of chemistry in the University of Alabama, has been elected associate professor of chemistry in the Johns Hopkins University. Dr. Stewart J. Lloyd, adjunct professor of chemistry and metallurgy, has been promoted to the professorship of chemistry in the University of Alabama.

DISCUSSION AND CORRESPONDENCE

ON "SOMA INFLUENCE" IN OVARIAN TRANSPLANTATION

TO THE EDITOR OF SCIENCE: May I take space in your columns for a brief discussion of the matter which Professor Guthrie presents in your issue of May 26, the diametrically opposite conclusions as regards the effects of ovarian transplantation reached, on the one hand by himself and, on the other, by Dr. Phillips and myself?

Beyond the point of clearly stating the essential difference in our conclusions and the ground on which this difference rests, I take it, neither Professor Guthrie nor I would care to go in the way of discussion.

The question at issue is first of all one of the sufficiency or insufficiency of evidence. Guthrie says regarding his own work (p. 816): "The primary object of the experiments was to determine if an engrafted ovary might retain its reproductive function. . . . And incidentally information on soma influence was secured." The incidental result happens to be the one of more general interest, but is impossible without the survival and functioning of "an engrafted ovary." So that the whole discussion narrows itself down to this: Has Guthrie presented adequate evidence that in his experiments an engrafted ovary *did* survive and function?

The facts are these. He transplanted the ovary of one hen into another hen. The second hen afterward laid eggs. Does it follow that the eggs came from that transplanted ovary? Not unless it can be shown that there was no other possible source from which they could have come.

What should we say to this sort of evidence? A boy rushes into the house. "Father," he says, "I have killed a hen." "How do you know, my son?" "Why, I threw a stone over the fence into the henyard, and when I opened the gate and went in, there lay a dead hen." Is that proof that the hen was killed by the stone which the boy threw over the fence?

To prove Guthrie's conclusion two facts must be established neither of which has he made any attempt to establish. These are, first, that the introduced tissue survived; and second, that no other ovarian tissue was present in the engrafted animal. Our own experiments show that in guinea-pigs engrafted ovarian tissue *taken from another animal* survives in only a small percentage of cases, and further that complete castration of the female is difficult. Even though every apparent vestige of the ovary is removed, nevertheless a functional ovary may later be developed at the original ovarian site. This possibility for fowls Guthrie ignores, yet in fowls complete castration would seem to be a much more difficult matter than in guinea-pigs, because of the diffuse nature of the ovary and its close adherence to large blood vessels. It seems to me essential to Guthrie's contention that he should establish his ability completely to castrate a hen. This he has not done. For if the hen can not be castrated, what warrant have we to speak of somatic influence in the offspring of grafted hens, these offspring being of doubtful origin? I can think of only two ways in which the survival of engrafted ovarian tissue could be established, viz., (1) by transplanting the ovary into some situation other than the normal one and subsequently demonstrating its existence there by autopsy and histological examination. This, the most direct and certain method, we have used with success in a number of cases, as have also several earlier investigators, whose work has been reviewed by Dr. Phillips and myself. Guthrie is prevented from employing this criterion by his uniform practise of transplanting the ovary to the original ovarian site. There is left to him only the criterion next to be mentioned, viz., to judge by the character of the young produced by the grafted animal. He finds in general that the young strongly resemble the grafted mother. Now, this fact admits of two interpretations, one of which Guthrie offers; the other has been offered by Phillips and myself. Guthrie holds that the introduced ovarian cells changed their character to conform with that

of the animal in which those cells were contained; we hold that it is unnecessary to assume such a change, but that the young were like the mother because she *was* their mother, and that they developed from *her own ova*, not from those introduced. We have shown elsewhere by a detailed examination of the facts reported by Guthrie that there is nothing in them at variance with the known facts of color inheritance in fowls, if it be supposed that in these experiments the mother furnished her *own* ova to produce offspring. But if it be supposed, as Guthrie does, that the ova came from an engrafted ovary, then serious contradictions are encountered as regards the color inheritance. Such contradictions Guthrie may not lightly push aside by disclaiming any interest in laws of inheritance on the ground that they are of "no concern" to him. He who claims to have modified inheritance should know what *normal* inheritance is, and he can not divert attention from chickens by scornful references to "peas," nor from stubborn facts by thrusts at "theories built largely upon speculation." No theories are involved in this discussion except the one which Guthrie has propounded, that inheritance is affected by foster-mother influence. We are concerned merely with facts which may either substantiate or disprove this hypothesis. It happens that the subject of color inheritance in fowls has been an object of careful study by several competent observers for a number of years, and we have a large body of data on the normal inheritance of black and white in crosses of fowls. Is it wise in discussing a supposed case of modified color inheritance in fowls to disregard this data as of "no concern"? Is breeder's evidence of "no concern" in a question of modified breeding?

To sum up in a few words our criticism of Guthrie's "evidence of soma influence," we hold that no satisfactory evidence of such influence has been produced because first, it has not been shown that a hen can be completely castrated, but if this can not be done, we can not be certain that eggs discharged from the ovary were really derived from introduced tissue and not from a regenerated ovary. Secondly, it has not been shown that in Guthrie's experiments the transplanted tissue actually persisted. Without the fulfillment of *both* these conditions no transplantation experiment can be considered critical.

Guthrie calls attention to the fact that in an early announcement of his results he drew only provisional conclusions. This is quite true; they were in their entirety as follows:[1]

1. "The ovaries transplanted in these chickens seemed to function in a normal manner."

2. "The color characters of the resulting offspring appeared to be influenced by the foster-mother."

No exception can be taken to these modest conclusions. No claim is made in them of more than a *seeming* persistence of engrafted tissue and an *apparent* modification of the color characters of the offspring, which however at the present time we are in a better position to explain.

If we are to understand that in the present paper Guthrie means merely to reassert these original conclusions, I make no objection to them.

It did *seem*, as Guthrie stated, that in his experiments the transplanted ovaries functioned, but that is no proof that they *did*. Our criticism of Guthrie's results is directed merely toward establishing this point. Doubtless it *seemed* to the boy who threw the stone into the poultry yard that he had killed the hen, but I doubt whether his father would have accepted that conclusion without some independent investigation. Such an investigation of Guthrie's results, Phillips and I have made.

In a case which we have fully described elsewhere the two criteria of the persistence and functioning of transplanted ovarian tissue which have been enumerated are, I believe, adequately met. That Guthrie does not share this view is of little consequence in this connection, but in stating his reasons for dissent Guthrie, doubtless inadvertently,

[1] *Journ. Exp. Zool.*, 5, p. 571.

misstates certain facts which I can not pass over in silence, lest this be interpreted as assent. He states, first, that we used "mongrel stock." "Therefore, any evidence furnished by the character of the offspring would be of doubtful value." On what Guthrie bases this statement I am unable to discover. It is wholly contrary to fact. We described in the body of our paper "one successful case" and in a postscript a second case complete except as regards the autopsy. In describing the successful case, p. 8, the statement is expressly made that the ovary was taken from "a pure black guinea-pig." This guinea-pig belonged to a family of coal-black animals which I have had for about seven years. This family is descended without admixture of other blood from three original individuals, a male and two females, all intensely black, the progeny of which have been closely inbred now for several generations without ever producing any observable deviation from the solid black type of the progenitors. The albino grafted was also of pure race, one which I have bred for about ten years. The albino male with which the grafted animal was mated was of a different strain, but of known and tested gametic composition, so that I can state with much positiveness the kind of young which he produced (and would regularly produce) in matings with guinea-pigs of different color varieties.

The second successful case, described in a postscript, concerned a color variety which I originated, the brown-eyed cream, and which breeds very true, since all the color factors which it contains save one are recessive in nature. This variety *can* produce only one variety of colored young. It is the *ultimate recessive* colored variety of guinea-pig. Having originated this variety some years ago and bred it pure and in crosses ever since, I think I may justly claim to know something about its behavior in inheritance. In neither of the cases which we have described as "successful" was an animal used whose breeding capacity was not definitely and fully known, as definitely as we know what will happen when oxygen and hydrogen are combined. The charge of "mongrel stock" is therefore groundless.

Guthrie's second criticism of our evidence is this, "It is not proved that the offspring may not have come from ovarian tissue of the host left in site after operation." But both the grafted animals were albinos and they were mated only with albino males. In all recorded cases, of which I have myself observed many hundred, albinos so mated produce only albino young. Had ovarian tissue been left in site after operation and liberated ova which developed, these should have produced *albino* young. But these grafted albinos, which had received an ovary from a colored animal, produced *colored* young, in each case of the particular color type that characterized the animal furnishing the graft. Is there really then any uncertainty about the source from which the functioning ova came?

W. E. CASTLE

LABORATORY OF GENETICS,
BUSSEY INSTITUTION,
HARVARD UNIVERSITY,
June 21, 1911

MEASURING THE MERIT OF ENGLISH WRITING

TO THE EDITOR OF SCIENCE: Professor Thorndike's article in SCIENCE of June 18 on a scale for measuring the merit of English writing, seems to parallel the old question: "Which is best, a pair of scissors or a pair of tongs?"

To have any value as a test of merit the writing of "pupils in their teens" should be comparative, and you can not properly compare paragraphs based on different topics, recollections or quotations from school readers, and attempts at expression of totally distinct emotions.

One method which might approximate to a basis of comparison would be to require from all the pupils a paraphrase of one single paragraph, as far as possible to be expressed in entirely different words from the original. Even this would be subject to the objection that a child writes best when it writes of something it naturally appreciates, and in which its interest is not forced; and the same

bit of writing would rarely appeal to any large number of children in an equal degree or in the same way; consequently their relation to it would not be of a strictly comparative kind in a literary sense.

The examples given seem to me absolutely valueless for comparison. Number 607 is the production of an idiot. Number 520 is a quotation; no child in its teens could have conceived it. Number 434, if a genuine original, is the only one showing anything but a lesson poorly remembered, it is the only one not quoted or paraphrased from an adult production which has any literary merit at all.

Wm. H. Dall

Smithsonian Institution,
June 19, 1911

GENOTYPES ARE THE SPECIES UPON WHICH GENERA ARE BASED

The case presented by Dr. Stiles on page 620 of Science for April 21 last, possesses exceptional importance for the student of muscoid flies. Probably in no other superfamily of animals have as many misidentifications been made as in the Muscoidea. Species have been repeatedly confused, combined, jumbled and wrongly determined ever since the time of Meigen, if not before, until the tangle has now become frightfully intricate in character. Especially within the past decade or two have misidentifications of North American forms enormously increased, so that the literature is now overburdened with the resulting error, from which it will be a labor of great magnitude to free it.

The principle involved in misidentifications or cases of mistaken identity is always the same for all cases, and the problem is capable of only one correct solution. Of two diametrically opposed propositions, one must necessarily be right and the other wrong. While I can see the case clearly from both points of view, the wrong premises of the one view stand forth distinctly in my mind, and I can not grant that there exists here any necessity for arbitrary decision. The whole matter rests, of course, upon the adoption of rational and correct premises. Properly approaching the question, its solution is simple, and I need only repeat here the axiomatic title at the head of these remarks.

The correct and only logical premises are represented in the axiom that EVERY RECORD OF A SPECIES OR OTHER TAXONOMIC UNIT IN THE LITERATURE BECOMES AT ONCE A PART OF THE SYNONYMY OF THE SPECIES OR UNIT INTENDED FOR RECORD BY THE RECORDER. It makes no difference under what name the record be made, the entity referred to remains the same, and the synonymy of that entity is thereby enriched by the name used followed by the name of the author making the record together with the date of same. This precludes confusion whether or not misidentification exists. The genus *X-us Jones, 1900*, unmistakably has for its type, under the conditions of the problem as stated, the species *albus Jones, 1900*. The genotype can be no other than this, which is the particular form so identified by Jones at the time and by him intended as the type of his genus. Jones has misidentified his genotype with Smith's species, hence the name *albus Jones, 1900 (non Smith, 1890)*, becomes a synonym of the name that shall finally hold for the genotype, that is to say, the particular form indicated by Jones. It is conceivable that Jones might differently identify the same form at different times, hence the necessity for a synonym to take the date of publication, which should include the month and day if Jones is a voluminous and frequent publisher.

The fallacy of the opposite premises is very evident. Were we to admit the latter it would be impossible to present a rational synonymy of forms. In the above case, albus Smith, 1890, has no further connection with the matter in hand after it has been proved that albus Jones, 1900, is a different form. It should be evident that an author's record of a form must remain always a record of that form in his sense at the time of record. The name he uses is merely a handle by which we can ourselves find and locate that form. If we ever decide that a record of a form is *not* a record of the form in the sense

intended to be recorded, we are clearly on the wrong road. And this is exactly where we should be were we to decide in the above stated question that the record of albus Jones, 1900, is not a record of albus Jones, 1900, but a record of albus Smith, 1890, knowing the contrary to be the case. The wording of the question itself in Dr. Stiles's title carries the correct solution. The species upon which a genus is based is necessarily the type of that genus. If it be found that the species has been erroneously determined, the determination must be corrected, and if it is found to be undescribed it should be at once characterized by the discoverer of the erroneous determination or some one else; otherwise the genus might by some be held to fall, being left without a described type species that can be designated. I would suggest that a special provision be made for such cases, whereby the genus need not fall in event of its type species proving undescribed. It can always be referred to by the name used in the original record, as albus Jones, 1900 (non Smith, 1890), until it can be better characterized. The species, whatever it prove to be, remains the type in the end.

Suppose the case of A and B, two men who are look-alike twins. I am acquainted with A, but I am ignorant of the existence of B. I see B, whom I believe to be A, commit a crime, and I give evidence in court, in my mistaken but conscientious belief, due to a misidentification of individuals, that A committed the said crime. Does this make A the criminal in the case, or does B remain the criminal? I think no argument is needed to show clearly that the person whom I saw commit the crime is bound to remain the criminal in the case, regardless of the name by which I designate him; my A is synonymous with B. Entities must be maintained. If individuals are confounded, their individuality is lost.

Following still further the principle of mistaken identity, it is evident that an author can not correctly put a previously published record into his synonymy without correctly ascertaining the identity of the forms concerned. It is equally evident that, whether he has or has not correctly ascertained the same, he personally, and no other, is responsible for the synonymy published under or over his name. Still further, it is evident that, if his synonymy be found incorrect, it does not hold, and the status of the particular forms which he has wrongly so indicated remains the same as before. No synonymy is entitled to recognition unless founded on material studied, hence the detection of error carries with it a location of the material under consideration at the time by the said author. If the points involved in the same ever become of sufficient importance to warrant, then the forms represented in the said material must properly, for synonymic purposes, take the names by which the said author recorded them plus his own name and date.

The element of protection demands consideration. It is evident that a taxonomic unit once correctly defined and named must be recognized and protected from distortion. What protection has albus Smith, 1890, if we allow it to be cited as the type of a genus that not only was manifestly not intended for it by its author but may even prove to be incompatible with it in its characters? If the characters of the genus X-us Jones, 1900, are not stated by its author, the same are to be found only in the material of albus Jones, 1900. If no such material has been studied and the new genus has been proposed on the strength of the description of the genotype cited, then no misidentification exists and the case as stated does not apply. Likewise if the type material of the genotype is cited the case does not apply. All phases which do not carry the misidentification principle may be similarly eliminated from the present consideration.

Those who would maintain, in the face of the above remarks and under the conditions of the question, as stated by Dr. Stiles, that albus Smith, 1890, is the genotype of X-us Jones, 1900, can in my opinion have no other excuse for their action than the desire to shirk taxonomic responsibilities because they involve increased labor. Clearly an author

has no right to treat a subject in the literature without complying with the responsibilities which his treatment, so far as it goes, demands. If he does so, he alone is at fault and he alone must suffer. Slipshod taxonomic methods carry their own germs of decay. If I myself have offended in this respect, I neither deserve nor desire sympathy as to the particular points of my offense. Every author's work must be verified until it becomes apparent that correctness has been attained. In this manner only can we put taxonomy on a sound basis. It is evident that the desired consummation of demonstrated taxonomic correctness for most forms is a long way off; but deplorable as this may be, and as difficult of achievement as it is deplorable, we can not in any event justly dodge the points at issue. Nomenclatorial problems must be fairly met or we shall never attain the desired end.

I have heretofore held aloof from discussions of nomenclatorial intricacies in general, knowing that the conditions of muscoid taxonomy are at present such that few cases can yet be definitely stated, although the future holds a multitude of them for ultimate solution. But I consider that the necessity for deciding the present question as above suggested is of such paramount importance to the welfare of future taxonomy that I have, at the risk of prolixity, presented the evidence both direct and indirect as fully as I am able to see it at the present time. The effect of the final decision by the international commission of questions involving the misidentification principle will have the utmost bearing on muscoid taxonomy, from which confusion will never be eliminated until we know the morphology of the reproductive system, egg and early stages thoroughly, as well as every detail of the external anatomy of the fly, and perhaps all the details of its internal anatomy. The conditions in the Muscoidea are quite unique, forms belonging to distinct genera and tribes, or even distinct subfamilies, often being closely similar in external adult structure. Many authors have in consequence sadly mixed and confused distinct forms throughout their work, and if we ever decide against the *intent* of an author it goes without saying that we shall be irretrievably lost in muscoid synonymy. Correct interpretation of an author's meaning is as important to us as priority in nomenclature. Therefore the importance of securing a rational working decision can not be overrated.

CHARLES H. T. TOWNSEND

PIURA, PERU,
May 7, 1911

LATIN DIAGNOSIS OF FOSSIL PLANTS

AMONG the rather numerous nomenclatorial rulings of the International Botanical Congress which are considered retrogressive by a large number of systematists is that which requires the diagnoses of new species, genera, etc., to be in Latin (sic).

In order to test current opinion among paleobotanical workers a memorandum has been circulated by Professor Nathorst, of Stockholm, and Mr. Arber, of Cambridge, and the result, published in a recent number of *Nature*[1] will be of much interest to American systematic botanists.

The rather remarkable result of this interchange of opinion shows that every paleobotanist in Scandinavia, Great Britain and North America proposes to disregard this ruling of the congress.

The memorandum which was circulated contained the following statements of intention:

1. I do *not* propose to include a diagnosis in Latin in the description of any new species, genus or family that I may institute in the future, unless there appear to me, in particular cases, to be special reasons for so doing.
2. I will *not* refuse to accept new species, genera or families of fossil plants instituted by other workers in the future, solely on the ground that their description is not accompanied by a diagnosis in Latin.

This was signed, with some modification of wording in the case of Mr. and Mrs. Clement Reid and Professor Seward, by the following

[1] May 18, 1911, pp. 380, 381.

students: Nathorst, Bartholin and Halle, of Stockholm; Benson, Royal Holloway College; Berry, Johns Hopkins; Cockerell, University of Colorado; Gordon, Edinburgh University; Hartz, Copenhagen; Hickling, Stopes, Watson and Weiss, of Manchester; Holden, Nottingham; Hollick, New York Botanical Garden; Jeffrey, Harvard; Kidston, Stirling; Knowlton and White, of Washington; Lewis, Liverpool; Maslen, Oliver and Mr. and Mrs. Clement Reid, of London; Möller, Sweden; Mr. and Mrs. D. H. Scott, Oakley, Hants; Arber and Thomas, Cambridge; Wieland, of Yale.

Judging by the protests one hears in the United States and the accounts of the Botanical Congress, it would appear that a good many of the rulings which it adopted are very far removed from being international in character or origin. Certainly its proposals regarding fossil plants, which emanated for the most part from Berlin, did not display much insight into the subject.

EDWARD W. BERRY

EXECUTIVE RESPONSIBILITY

TO THE EDITOR OF SCIENCE: May I trespass on your space to the extent of replying briefly to the criticism by Professor A. D. Mead in your issue of June 23, of my letter on academic tenure, which was printed in SCIENCE on May 12?

Professor Mead's criticism has such a moderate tone, and there is so little in it that at all affects the tenability of my position, that it would not demand a reply were it not for the fact that it seems to imply that the "freedom of opinion and utterance" he declares to be so well guaranteed to the Brown faculty, should not extend to the columns of SCIENCE as well; and that it has other implications which suggest the workings of the theological rather than the scientific mind, by a reliance on dogmatic assertion instead of evidence.

Professor Mead admits that men have been removed from the Brown faculty, but declines to enter into any "futile controversy" over the cause. They must have been removed justly, he argues, because the charter forbids such action for anything else than "misdemeanor, incapacity or unfaithfulness," and the present administration only enforces it for such reasons. This may be the case, but we have no evidence of its being so except Professor Mead's opinion; and that is offset, in my mind at least, by the assurance of several present and past members of the Brown faculty, that tenure is extremely uncertain there, and that arbitrary removals are frequent.

There are always two sides to any question, and it would be unjust to accept the statements of men who have been removed from the Brown faculty, as unbiased evidence. The statements of such men, however, that I have heard made with increasing frequency during the last few years, go far to call into question, if they do not disprove, the assertion of Professor Mead that men of long service in the university are not removed until they are given a "reasonably fair chance of readjustment in other positions." Of course there is room for difference of opinion as to what constitutes a reasonably fair chance; but I question very much if, even after the statements of these men had been much discounted to allow for personal interest, an ordinary jury would agree that they had had much of anything in the way of a chance to readjust themselves in new positions.

Leaving out of the question, however, the statements of men who have been removed, a case is made out against the Brown administration by the very arguments with which Professor Mead tries to justify its course. He admits that men have been appointed to various professorial grades and continued in them for years, only to be removed afterwards by the same administration that advanced them. Such a course as that can not be justified, and the attempt to do so by statements about "having reached the limit of growth in the environment of the particular institution," should be very severely reprehended by everyone who desires to save education from serious discredit. Even in our largest institutions too much is said about the necessity for rare and special talents, and in Brown,

where the problems of instruction are less varied, such remarks have even less justification. The qualities that make a successful teacher, in any environment, are high character and wide knowledge; and a very few years trial should suffice to inform the discerning and disinterested judge whether or not a man possesses these essentials. If he does not there is no justification for retaining him, no matter how much money or inconvenience is saved by doing so. If he does there is no justification for removing him, no matter how much money doing so releases for other purposes, or how much the administration believes in his incapacity, so long as it has no other evidence of it to offer to the public except vague general statements about environmental unfitness, and having reached the limit of growth. Such statements are based altogether too much on personal opinion and on intangible, esoteric considerations to justify action so serious in its consequences as removal from an academic position always is.

SIDNEY GUNN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY,
July 3, 1911

ACADEMIC AND INDUSTRIAL EFFICIENCY

To THE EDITOR OF SCIENCE: Referring to Mr. Handschin's letter concerning academic and industrial efficiency in your issue of June 9, I feel that it should be said that it is very doubtful whether the efficiency of educational institutions can be compared in any way with the efficiency of industrial concerns.

I very much doubt the unsupported thesis: "But the institution which pays the most to 'productive' labor is the most efficient." If a railroad were to be built by hand labor the labor cost would be relatively high, but I fancy no one would say that the work was efficiently done. Indeed, it may be stated with almost no other support than our general knowledge of things that in proportion as new machinery is devised to take the place of hand labor the efficiency of production is increased.

In general, efficiency, as the word has been recently used, is the ratio of useful energy of one form recovered to total energy of another form supplied or destroyed. I should like to inquire who can measure the total energy supplied by a teacher or the useful energy recovered?

Without question there are certain economies that may be realized in the conduct of an educational institution of any kind, but, while these economies must not be overlooked, they are the least important of all of the items to which attention should be given. In most of the discussion that has appeared it has seemed to me that the duties of the college and the university have been confused. Whatever may be the dictionary definition of a university, it is accepted as a place for research, a place where enthusiastic men may find encouragement and the means to assist them in their efforts to increase the world's store of knowledge. It is not necessarily an aggregation of colleges—it is not a commercial laboratory. Its duty, therefore, is to promote research with only so much control by a group of scholars as to make it reasonably certain that any study undertaken is worthy of effort. It is the duty of a college to give young men and young women a certain small proportion of knowledge already available, to teach them where and how to get more, and to endeavor to inspire them with a high sense of duty to their country, their neighbors, themselves and their God. This is as we know the college in America.

In its mechanical or commercial sense efficiency is not a word to be used in connection with this duty of the college, or the work of a university. The cost matters little if the duty and work are well performed.

I would not have this statement considered as a reflection upon the excellent report of Mr. Cooke to the Carnegie Foundation for the Advancement of Teaching, which report seemed to me to be full of suggestions of great value.

WM. G. RAYMOND

IOWA CITY, IOWA

THE METHODS OF A VETERAN INVESTIGATOR AND TEACHER

TO THE EDITOR OF SCIENCE: It occurs to me that some of my scientific colleagues may be interested in the following statement of what I regard as the most important educational and scientific outcome of fifty years of study and forty-two of teaching: (1) All parts of a given animal should receive one and the same serial number. (2) Slips should be used for promptly recording new observations, references, ideas, and all data (*e. g.*, localities, donors, modes of preparation) not ascertainable from the specimens themselves. (3) Beginners should be taught correct methods by explicit directions. (4) Before lecturing upon a species or a group there should be shown a specimen or a representation of one. (5) In all composition the following should be sought in the order named: clearness, consistency, correctness, conciseness, completeness. (6) Published errors should be promptly corrected. (7) All natural classification is dichotomous. (8) For the study of the structure, development, succession and relationships of vertebrates the best group to begin with is the Selachians, the sharks and rays; if several forms can be studied the first should be—and if but one, that one should be—the acanth or "horned dogfish," *Squalus acanthias*. (9) The objective study of the brain should begin in the primary school; the pupil himself should expose, draw and dissect the brain of the acanth shark; with successive appropriate changes as to forms and methods the high school graduate should have gained as much real knowledge of the human brain as is now possessed by the average graduate in medicine.

BURT G. WILDER

CORNELL UNIVERSITY,
June 20, 1911

QUOTATIONS

THE DEPARTMENT OF AGRICULTURE AND DR. WILEY

IT begins to look pretty clear that the real problem before the President in connection with the Wiley affair is how to let it drop with the least amount of disturbance and inconvenience. This does not imply that he will decide the matter without looking into its merits. His decision will not be made until he has personally examined the record. But it requires neither a gift of divination nor a preternatural command of legal intricacies to predict with a great degree of confidence that the recommendation made by the personnel board of the Department of Agriculture, and approved by Attorney-General Wickersham, will not be followed by Mr. Taft. Every day that has passed since it was made has strengthened not only the belief that the punishment proposed was utterly disproportionate to the alleged offence—even supposing that offence to have been of precisely the character asserted—but also the impression that the President is quite as well aware of this as anybody. The Washington news, in papers of all shades of opinion, has been steadily pointing in the direction of a smoothing over of the affair—not for Dr. Wiley, but for Mr. Wickersham.

Before the matter goes further, and the initial stages of it become hazy in the public mind, it is well to recall just what Attorney-General Wickersham did in the case. The personnel board of the Department of Agriculture had found that in the arrangement made by Dr. Wiley with Professor Rusby, an eminent pharmacological expert, the terms of a law limiting the compensation of experts employed by the Agricultural Department were violated. It was not alleged by anybody that Professor Rusby had been overpaid for his work; it was not alleged by anybody that Dr. Wiley's object in securing his services was anything but that of getting the best possible results for the government. The charge was simply that the law made \$4,000 a year the maximum pay for an expert, that it had been decided that this means that the *per diem* pay of an expert shall not exceed \$11, and that Dr. Wiley had made an arrangement for an annual compensation of \$1,600 to Pro-

fessor Rusby, in such a way as to result in his getting a *per diem* compensation greater than this obviously inadequate one, for the days that he gave up to the work. Now, nobody would have complained if Mr. Wickersham had informed the President that this is a violation of the law. Nobody would have found fault with him if he had expressed his opinion that such violation was a serious matter. But when he went outside his province as a lawyer and told the President that in his judgment this disregard of a peculiar regulation, in so small a matter, and without the slightest trace or suspicion or hint of bad motive, was sufficient reason for approving a recommendation calling for the resignation of a faithful public servant, filling with exceptional zeal and devotion an office of unusual importance, he invited just such criticism as he has been subjected to in the past few days.

In deprecation of such criticism, the curious point is now put forward that Mr. Wickersham's report was not intended to be made public, but was designed solely for the President's private information and guidance. This may be a good point for Mr. Taft himself to fall back upon, but it is difficult to see how it can do anything for Mr. Wickersham. If the report was one for the President's private ear, the President might, to be sure, throw it into the waste-paper basket; but that can not have been the purpose for which it was originally destined. So far as in him lay, Mr. Wickersham backed up the personnel board's recommendation; and it is impossible to see wherein there is any less demerit in the advice to do an act of injustice because the advice was given in secret. To most minds, we fancy, that is an aggravation of such an offence, not an extenuation. And it is impossible not to recall the fact that in the unhappy muddle over the Lawler memorandum in the Ballinger case, in which Mr. Wickersham bore a conspicuous part, a bungling policy of secrecy was responsible for the worst of the trouble.

There is another analogy between the present affair and that of the Ballinger-Cunningham-Pinchot difficulty which the President will do well to bear in mind. In this case, as in that, there are two aspects which the subject presents; in this case, as in that, everything depends upon maintaining a sense of proportion as between these aspects. There is the narrow view of the mere lawyer and the mere disciplinarian; there is the broad view of the man responsible for large and difficult affairs. It is not necessary to ignore the requirements of law or even the exactions of red tape in order to do justice to the larger things. But it is one thing to insist that even the most zealous and well-intentioned of officers must obey the law; it is quite another thing to permit the enemies that such officers are constantly making to seize upon little errors, or technicalities, or violations even of official etiquette, as a means of getting them out of the way. Such work as that of fighting land thieves or food adulterators demands enthusiastic zeal and inexhaustible energy; if you are going to make the situation impossible for a man who has these qualities unless he combines with them an immaculate record upon every technical point, you might as well surrender at once to the land-grabbers and the adulterators. And it is because the plain people understand this that they insist upon any such affair as the Ballinger case or the Wiley case being uncovered from top to bottom. Any attempt to confine it within narrow or technical bounds is sure to fail.—New York *Evening Post*.

SCIENTIFIC BOOKS

Contributions to Medical Science. By Howard Taylor Ricketts. Chicago, University of Chicago Press. 1911. Pp. ix + 497. $5.33.

The committee of the Chicago Pathological Society which was intrusted with the office of preparing a suitable memorial of Howard Taylor Ricketts have issued a memorial volume containing many of the chief original studies of this remarkable investigator.

The volume opens with a brief and dignified statement by Hektoen of the main events of Dr. Ricketts's career, ending in his untimely death in Mexico City from the deadly Mexican typhus, the disease whose secrets he

was pursuing. Then follows the well-known and now classical study by Ricketts on "Oidiomycosis of the Skin," and an important contribution by Benjamin F. Davis on "The Immunological Reactions of Oidiomycosis in the Guinea Pig," a work which grew out of and is partly based upon the observations of Ricketts. One is then reminded, by several articles, that Ricketts made important contributions in the field of immunity, in studies on lymphotoxic and neurotoxic sera, and on tetanus.

The main portion of the volume consists of the remarkable series of papers on Rocky Mountain fever, in which is found the history of the various steps which led to the unravelling of the mysteries of this disease. Some unfinished studies relating to the mode of transmission of the disease were taken up by Davis, Petersen, Moore and Maver, and their reports follow. LeCount contributes, with many illustrations, a report on the pathological anatomy of the disease based on the material collected in six autopsies performed by Ricketts. Finally come the preliminary reports of Ricketts and his colleague Wilder of their studies on Mexican typhus, in which they were able to show that the disease is communicable to monkeys, that it is transmitted by an insect, *Pediculus vestamenti,* and finally that it is probably caused by a bacillus which they succeeded in isolating from the blood of typhus patients and from the insects.

The volume appears to us noteworthy in several aspects. The scientific value of its contents, dealing with pioneer research in three important fields and practically covering the entire scope of essential knowledge in two of them, renders the work one of high scientific distinction and fully justifies its existence. The committee may be congratulated in perceiving what a rare opportunity existed of perpetuating the memory of a brief career by the simple record of its own activities.

These collected studies stand as a model of orderly and effective research guided by a keen imagination and scientific enthusiasm. The volume is a unique testimonial to the genius and energy of one of the most productive of American pathologists.

J. E.

The Geology of Building Stones. By J. ALLEN HOWE. London, Edward Arnold. 1910. Small octavo, pp. viii + 455.

This work, as stated in the editor's preface, is the fourth volume of a series of works treating of economic geology, the compilation being made mainly with a view to the requirements of students of architecture.

The volume contains, in a condensed form, a large amount of information gathered from sources easily recognizable, though foot-notes are lacking and credits given mainly for trifling statements of fact rather than ideas.

The work begins with an introductory chapter which includes a table of strata arranged after the English system. This is followed in order by chapters on the minerals of building stones; igneous rocks; sandstones and grits; limestones (including marble); slates and other fissile rocks. Pages 333–411 inclusive are devoted to discussions of the decay and the testing of building stones. In the reviewer's opinion too much stress is laid upon the latter subject and too little upon the first. No amount of testing by methods now known can compare in value to a study of the conduct of the stone in the quarry bed or in old buildings. Incidentally the statement on page 398, that the present writer made certain corrosion tests, is an error. Credit should be given to Professor J. A. Dodge, of Minneapolis, Minn.[1]

Naturally the descriptive portion of the work is devoted largely to English materials, but American and other foreign localities are not wholly overlooked.

As might perhaps be anticipated from the title, the various classes of sedimentary rocks are discussed with reference to their geological horizons. How far such an arrangement of the subject is desirable has always been a question in the reviewer's mind. Unless it

[1] See "Stones for Building and Decoration," third edition, p. 458.

can be shown that stone of the various horizons possess characteristics of their own it would seem that the question of position in the geological scale was wholly of minor importance. Kind, quality and accessibility are the only questions in which the man of affairs is interested or need concern himself.

In the appendices is given a list of the principal quarries, together with a bibliography, the latter confessedly incomplete and containing no reference to the important reports published in America by the geological surveys of Georgia, Maryland, Missouri, New York and North Carolina.

The work represents a laudable attempt to make certain information available to students of architecture. Whether successful or not the future must decide. At present the average architect seemingly contents himself with the purely decorative feature regardless of climate and incidental or consequential durability. Witness the proposed construction of one of the most elaborate ecclesiastical structures in America from one of the cheapest and least durable of natural materials. And this for no other reason than that the elaborate detail of ornamentation, the effect of light and shade, can not be produced in a better stone at what is considered a reasonable outlay of time and money!

GEO. P. MERRILL

Crystallography and Practical Crystal Measurement. By A. E. H. TUTTON, D.Sc., M.A. (Oxon), F.R.S., A.R.C., Vice-president of the Mineralogical Society; Member of the Councils of the Chemical Society, and the British Society for the Advancement of Science. New York, The Macmillan Company; London, Macmillan & Company, Limited. 1911. 8vo. Pp. xiv + 946, 720 figures in the text. $8.50.

This work aims to present a complete survey of the science of crystallography from the most modern point of view, including both the theory and practise of the study of crystals and their manifold properties. Avoiding the forbiddingly mathematical treatment of his English predecessors in the field the author has succeeded admirably in giving a living interest to crystallography such as is to be found elsewhere, if at all, only in von Groth's "Physikalische Krystallographie." The method of presentation differs however widely from von Groth's in that theoretical considerations generally follow on detailed descriptions of actual crystallographic investigations drawn from the author's wide experience. These practical details occupy a large part of this large volume and in many respects are its most distinctive and valuable feature. Tutton's work has been remarkable for the careful attention to detail which has rendered his results extraordinarily accurate; and for the completeness of his studies, made chiefly on artificial crystals. So that in the detailed records of measurement and the full description of structure and use of instruments and methods employed we have the best guide-book to actual crystallographic practise which has yet appeared. Concerning the actual measurement of crystal angles little that is new is claimed for the book; and indeed it is much to be regretted that the author treats so slightingly the use of the two-circle goniometer. But the descriptions of methods in density, optical, thermal and elasticity investigations form a most welcome contribution to the scanty literature in this domain of peculiar difficulty, and the author speaks here with the authority of an undoubted leader.

The chapters in which are traced out the historical development of the theory of homogeneous crystal structure are particularly well done and are of the greatest interest. The idea of molecular distance ratios is also fully worked out and its application abundantly illustrated.

The illustrations of the book are abundant and good; the crystal drawings almost all new, the figures of instruments very clear wood-engravings and the interference figures reproductions of the author's photographs.

In all respects the work is to be regarded as of unusually high excellence and of the first importance in the field of crystallography.

CHARLES PALACHE

HARVARD UNIVERSITY.

The Optical Properties of Crystals with a general introduction to their physical properties, being selected parts of the Physical Crystallography. By P. GROTH, Professor of Mineralogy and Crystallography in the University of Munich. Translated (with the author's permission) from the fourth revised and augmented German edition by B. H. JACKSON, M.E., M.A., of the University of Colorado. 8vo, xiv + 309 pages, with 121 figures in the text and two colored plates. Cloth, $3.50. New York, John Wiley & Sons; London, Chapman & Hall, Limited. 1910.

This is a partial translation of the well-known work of Professor von Groth, "Physikalische Krystallographie," which is generally regarded by those who have to deal with optical crystallography as the best non-mathematical treatise on this subject yet produced. The translation, to quote from the translator's prefatory note, "is made up chiefly of matter contained in Part I. of the original work, on the properties of crystals; besides embracing the general introduction and all that falls under the heading optical properties in this part, it includes also whatever may be found there on the influence of other properties on the optical properties. Short extracts from Parts II. (Systematic Description of Crystals) and III. (The Methods of Crystal Investigation) have been introduced, on occasion, for illustration and example."

The scope of the work may be gathered from the headings of the principal divisions which are as follows: General Introduction to the Properties of Crystals; The Nature of Light; Combination (Interference) of Plane-polarized Light; Optically Isotropic Bodies; Double Refraction of Light; Optically Uniaxial Crystals; Optically Biaxial Crystals; Recapitulation: Classification of Crystals According to their Optical Properties; Combinations of Doubly Refracting Crystals to show the Character of their Double Refraction; Rotation of the Plane of Polarization of Light in Crystals; Absorption of Light in Crystals; Influence of other Properties on the Optical Properties of Crystals including Thermal Properties, Elastic Strain by Mechanical Forces and by Electrical Forces, Permanent Strain, and Twinning.

The translation is excellent, the English being free and idiomatic but following closely the original text. The work is entirely within the comprehension of any student who knows the rudiments of crystallography and forms a much-needed and very welcome addition to the English text-books in the field covered by it.

The colored plates reproduced from the original work are excellent; I comprises a spectrum of white light and a Newtonian color scale of the first four orders; II presents the important types of interference figures in convergent light in thirteen figures.

An appendix contains a useful list of German and American supply houses for apparatus, models, crystals and preparations. English firms might well have been added to this list.

CHARLES PALACHE

SPECIAL ARTICLES

WEST ELIZABETH, PENNSYLVANIA, DEEP WELL[1]

I AM indebted to Dr. I. C. White,[2] state geologist of West Virginia, for calling my attention to the omission from my paper published in SCIENCE, May 26, 1911, under the title "Underground Temperatures," of an important deep boring made in 1897 in Allegheny County, Pa. The data relating to this well are so important as to be worthy of a separate note.

The well is located on Peter's Creek about two and one half miles west of West Elizabeth, Allegheny County, Pa., and about twelve miles south-southeast of Pittsburgh. It is the deepest well drilled in the United States

[1] White, I. C., West Virginia Geological Survey, Vol. I(A), 1904, pp. 103–107. Hallock, W., "Subterranean Temperatures at Wheeling, W. Va., and Pittsburg, Pa.," *School of Mines Quarterly*, 1897, Vol. XVIII., pp. 148–153; see especially pp. 151–153.

[2] Personal communication, June 6, 1911.

and was put down by the Forest Oil Company in 1897. The well was dedicated to science and had for its purpose drilling down and into the Corniferous limestone, but after a depth of 5,575 feet was reached an accident beyond repair occurred and further drilling was from necessity abandoned. The well was begun 130 feet below the Pittsburgh coal, and after passing through rocks of the Carboniferous (Pennsylvanian and Mississippian) and of the Upper and most of the Middle Devonian, was bottomed (5,575 feet) in supposed Marcellus black shale, probably not more than 100 feet above the Corniferous limestone. The vast thickness of rocks penetrated by the well were all sedimentaries, including, according to the log,[3] shales, slates, coal, sandstones and limestones, as the chief lithologic types.

At the request of Dr. White, Professor William Hallock, of Columbia University, was afforded every facility for measuring the temperature of the well. A brief statement of the temperatures measured in the well was published by Professor Hallock in 1897.[4] Five measurements made at different depths are recorded by Dr. White. These may be tabulated as follows:[5]

TEMPERATURE MEASUREMENTS IN WEST ELIZABETH DEEP WELL

Temperature at		Difference in temperature for		Kind of rock
525 ft.	57° F.			Sand.
2,252 ft.	64	1,677 ft.	7° F.	Slate
2,397 ft.	78	445 ft.	14	Slate and shells.
5,010 ft.	120	2,613 ft.	42	Limestone.
5,380 ft.	127	370 ft.	7	Slate.

The figures in the table above explain themselves and need no comment except that the increment of heat is shown to be exceedingly variable, and is in accord with many other deep wells over the earth's surface in which temperature measurements have been made. The explanation offered for the variation in temperature shown in this well is the presence of a considerable flow of natural gas from the Bayard sand at 2,282–7 feet.[6] The average increment of heat for a depth of 4,855 feet, which represents the difference between the least (525 feet) and the greatest (5,380 feet) depths at which temperature measurements were made, is 1° F. for every 69.3[7] feet.

THOMAS L. WATSON

UNIVERSITY OF VIRGINIA

[3] A complete log of the well is published by Dr. White in Volume I(A) of the West Virginia Geological Survey, 1904, pp. 104–107.

[4] Hallock, W., *School of Mines Quarterly*, 1897, pp. 151–153.

[5] Data taken from Vol. I(A) of West Virginia Geological Survey, 1904, pp. 104–107.

[6] Professor Hallock states that "the thermometers at 2,250 feet indicated a cooling due to the expansion of the gas amounting to about 14°." *Op. cit.*, p. 153. Gas, volume 25 lbs. per min., West Virginia Geol. Survey, Vol. I(A), p. 105.

[7] Professor Hallock gives the increment of heat from top to bottom (5,000 feet) of well as 1° F. for 71.5 feet. *Op. cit.*, p. 150, table II.

ADDITIONAL NOTE ON RETICULATED FISH-SCALES

SINCE the publication of my recent account of dipnoan fish scales in SCIENCE, some interesting facts have come to light.

1. Dr. L. Hussakof, of the American Museum of Natural History, has very kindly placed in my hands scales of *Sagenodus* from the Carboniferous rocks of Mazon Creek, Illinois. A well-developed scale is oval, about 50 mm. long and 37 broad, and in appearance and structure essentially agrees with the scale of the living (Australian) *Neoceratodus*. The reticulations are evident, and the very fine basal longitudinal fibrillæ are minutely tuberculate. Thus we have positive evidence of the enormous antiquity of this type of scale, including even the details of structure.

2. A specimen of the sucker *Moxostoma cervinum* Cope, collected by Dr. B. W. Evermann, proves to have two kinds of scales. One has a quadrate form, with strong laterobasal angles, strong apical and basal radii, the circuli dense in the basal and lateral fields, but widely spaced in the apical. This is the sort of scale we are accustomed to find in *Moxostoma*, a scale strongly suggestive of various old-world cyprinids. The other type of scale has the laterobasal angles more rounded, radial lines running to the margin

all around, and the very broad central area occupied by irregular, more or less elongated reticulations. Thus the scale comes to closely resemble those of the Mormyridæ. As it now seems evident that the ancestors of the Teleosteans must have had reticulated scales, or at least that the ordinary radial sculpture is derived from the reticulated type, this *Moxostoma* scale must be regarded as uniquely primitive or atavistic for the general group to which it belongs.

3. Dr. G. A. Boulenger has very kindly sent me scales of the cæciliid amphibian *Ichthyophis glutinosus.* These are very small, embedded in the skin, cycloid in form. The pattern is extremely characteristic, consisting of concentric grooves connected at intervals by cross-lines, the whole effect being like that of bricks in a wall. The concentric grooves are probably not circuli, nor can I make out anything corresponding to the circuli of fishes. In parts of the scales, however, the markings become irregular, producing a reticulation which closely simulates that of the reticulate-scaled fishes. I believe that the scales are really comparable to fish-scales, and that the sculpture is the same as the radial sculpture of fishes. No fish scale has been seen resembling in detail that of *Ichthyophis;* such scales as those of *Chrosomus* are superficially similar, but owe their circular lines to different elements.[1]

T. D. A. COCKERELL

UNIVERSITY OF COLORADO

[1] Since this was written, I have found that a deep-sea eel, *Synaphobranchus pinnatus*, has scales curiously similar to those of *Ichthyophis.*

NOTES ON THE GENUS TYPHA AND ITS NEMATODE ROOT GALL—HETERODERA RADICICOLA (GREEFF) MULL.

DURING the summer of 1908, while investigating some problems connected with the root system of *Typha latifolia,* I found a number of abnormal growths on the rootlets. These growths appeared as irregularly spherical or fusiform enlargements, varying in size from 1 to 5 mm. in diameter. They were identified by Professor Atkinson as root galls caused by the nematode *Heterodera radicicola.* I have collected these galls at the same station (limnology station of Cornell University) three successive years, but have never found them on *Typha* in any other locality.

Professor Atkinson[1] thought, from his observations of this worm on potatoes and tomatoes, that, if favorable opportunity should occur for its introduction in the north, it might become a pest. Webber and Orton[2] say it will never become a serious pest in the north, as severe cold kills the worm. Van Hook[3] reports the worm as wintering in ginseng beds which had been mulched and also in protected forest beds. This worm has been a serious pest to ginseng in the north.

Stone and Smith[4] found the galls on outdoor plants, but concluded that they were transient.

The plants observed by me in the Cayuga marshes are located along the shore line of one of the arms of Fall Creek where moisture is plentiful in the soil all winter. Winter observations prove that the soil in which the galls are found does not freeze. None of the galls have been found more than eighteen inches below the surface.

L. N. HAWKINS

[1] Bull. 9, Alabama Exp. Sta.

[2] U. S. Dept. Agr., Bur. Plant Ind., Bull. 17, 1902.

[3] Cornell Agr. Exp. Sta., Bull. 219, 1904.

[4] Bull. 55, Mass. Agr. Exp. Sta., 1898.

CORRELATION NOTES

IN describing the fauna of the Moorefield shales of Arkansas[1] Mr. George H. Girty lists and describes the following fossils among others from the region: *Productus inflatus* var. *coloradoensis* Girty (?),[2] *Productus arkansanus* var. *multiliratus* Girty,[3] and *Diaphragmus elegans* Norwood and Pratten.[4] By a comparison of the figures of these fossils on plate iv.[5] with fossils which the writer collected

[1] "The Fauna of the Moorefield Shale of Arkansas," U. S. Geol. Survey, Bulletin No. 439.

[2] *Ibid.*, pp. 42–43.

[3] *Ibid.*, p. 43.

[4] *Ibid.*, pp. 51–52.

[5] *Ibid.*, plate iv.

at Fort Apache, Ariz., in 1902, he finds that the three fossils mentioned are abundantly represented in the lower Red Wall there, especially in the limestone series that caps the formation on the mesas east of the North Fork of White River.[6] Specimens of these species, collected from this region then, are to be found in the writer's collection in the Geological Museum of the University of Indiana. The finding of the similar fossils in the two districts would seem to indicate that the strata concerned are relatively of the same age.

Albert B. Reagan

Nett Lake, Minn.

SOCIETIES AND ACADEMIES

THE TORREY BOTANICAL CLUB

The meeting of April 11, 1911, was held at the American Museum of Natural History at 8:15 P.M. Dr. E. B. Southwick presided.

The regular order of business was dispensed with and the announced lecture of the evening on "Poisonous Mushrooms," by Dr. W. A. Murrill, was then presented. The lecture was illustrated with many lantern slides. An abstract of the lecture prepared by the speaker follows. A more complete discussion of the subject by Dr. Murrill may be found in the November number of *Mycologia* for 1910.

"Considering its importance, it is remarkable how little is really known about this subject, most of the literature centering about two species, *Amanita muscaria* and *Amanita phalloides*, which have been the chief causes of death from mushroom eating the world over.

"As the use of mushrooms in this country for food becomes more general, the practical importance of this subject will be vastly increased, and it may be possible to discover perfect antidotes or methods of treatment which will largely overcome the effects of deadly species. This would be a great boon even at the present time, and there will always be children and ignorant persons to rescue from the results of their mistakes. Another very interesting field, both theoretical and practical in its scope, is the use of these poisons in minute quantities as medicines, as has been done with so many of the substances extracted from poisonous species of flowering plants, and even from the rattlesnakes and other animals. Thus far, only one of them, the alkaloid muscarine, has been so used.

"The poisons found in flowering plants belong chiefly to two classes of substances, known as alkaloids and glucosides. The former are rather stable and well-known bases, such as aconitine from aconite, atropine from belladonna, nicotine from tobacco and morphine from the poppy plant. Glucosides, on the other hand, are sugar derivatives of complex, unstable, and often unknown composition, such as the active poisons in digitalis, hellebore, wistaria and several other plants.

"The more important poisons of mushrooms also belong to two similar classes, one represented by the alkaloid muscarine, so evident in *Amanita muscaria*, and the other by the deadly principle in *Amanita phalloides*, which is known mainly through its effects. Besides these, there are various minor poisons, usually manifesting themselves to the taste or smell, that cause local irritation and more or less derangement of the system, depending upon the health and peculiarities of the individual.

"The principal species of poisonous fungi were illustrated by colored lantern slides, the series containing *Amanita cothurnata* Atk., *Amanita muscaria* L., *Amanita phalloides* Fries, *Amanita strobiliformis* Vittad., *Clitocybe illudens* Schw., *Inocybe infide* Peck, *Panus stypticus* Fries, *Russ emetica* Fries, and several other poisonous species of interest."

The meeting of April 26, 1911, was held in the museum building of the New York Botanical Garden at 3:30 P.M. Vice-president Barnhart presided.

The first number on the announced scientific program was a paper, on "Fern Collecting in Cuba," by Mrs. N. L. Britton. This paper is published in full in the *American Fern Journal*, Vol. I., p. 75.

The next number was a discussion of "Fern Venation," by Miss Margaret Slossen. A more complete discussion of the subject by Miss Slossen may be found in her book "How Ferns Grow."

The meeting then adjourned to the Fern House of the New York Botanical Garden under the guidance of Mrs. N. L. Britton for a further study of ferns.

B. O. Dodge,
Secretary

[6] Reagan, Albert B., "Geology of the Fort Apache Region in Arizona," *American Geologist*, Vol. XXXII., pp. 265–308.

SCIENCE

Friday, August 4, 1911

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

THE SCOPE OF PROTOZOOLOGY[1]

Twenty-one years ago when I first began the study of protozoa, biologists in general were inclined to look upon these animals mainly as a means of entertaining amateur microscopists in their idle hours. Since then the subject has developed in widely different directions and protozoa have found a place in the deeper problems of biology; indeed, they are considered important enough to warrant the establishment of several chairs of protozoology in different parts of the world.

I am frequently asked to tell what protozoology is, and occasionally find difficulty in correcting the impression that a protozoologist is a primitive and undeveloped zoologist; but difficult as this sometimes is, I find even greater difficulty in giving an adequate idea of the scope of protozoology. I have chosen, therefore, as the subject of this lecture, this very general topic. In it I have no pet hypothesis to develop, nor scientific nut to crack, but desire only to point out the nature of the work done in protozoology as a basis for a definition of its scope.

Up to 1890 the work on protozoa was largely descriptive. The first discoveries by Leeuwenhoek in 1675 gave a new lease of life to the theory of spontaneous generation which had received some hard knocks through the direct experiments of Redi, Malpighi and Harvey. The new discoveries with the microscope merely added fuel to the fire of the later nature philosophers, which, however, mostly went up as smoke theories, such as that of organic transmi-

[1] Lecture delivered at the Marine Biological Laboratory, June 30, 1911.

gration, as developed by Buffon in France, and Needham in England. These naturalists saw in the Leeuwenhoek animalculæ only the disintegrated and free-living parts of higher animals and plants. It can not be stated positively, but there is nevertheless some reason for believing that the smouldering embers of this philosophic fire were kept alive by Oken and Goldfuss in Germany, and by Bichât in France and finally fanned into the full blaze of the cell theory by Schleiden and Schwann, ninety years afterwards.

In the meantime the work of O. F. Müller (1786), and especially that of C. G. Ehrenberg (1833–1838) and F. Dujardin (1835–1841) had resulted in some taxonomic order amongst these microscopic forms which Cuvier had generously included in the animal kingdom under the name of chaos animalculæ. Other important steps were taken by von Siebold in 1845 who first described protozoa as single-celled organisms; by Max Schultze in 1863, who showed that the living substance "sarcode" of protozoa is the same as the living substance "protoplasm" of higher animals; and by Bütschli in 1875 who gave the final evidence in support of the unicellular nature of protozoa by showing that the nucleus of the protozoan cell is similar to that of the tissue or egg cell, and like the latter, divides by karyokinesis.

Bütschli's later work of 1882–88 gave the real ground work on which modern protozoology rests. Summarizing all of the preceding discoveries and bringing together the disconnected observations and theories of his predecessors, he gave us in these approximately 1,700 pages of acute criticism careful observations, lucid descriptions and logical deductions, a masterful zoological treatise such as rarely appears in these days.

I have arbitrarily chosen the year 1890 as a dividing point in the history of protozoology. Before this the work was chiefly descriptive and taxonomic, after this it became more speculative and experimental, although it also developed along the quite unexpected lines of practical biology and public hygiene. For my purpose here I shall not speak of the splendid descriptive work, especially on parasitic forms, that has been done since 1890, but will devote my time to a short statement of the activities in certain other lines of protozoology, especially the cytologic, pathogenic and general biological.

I. THE CYTOLOGIC SIDE

In a strict sense all work on protozoa might be classed as cytological since it has to do with the single cell. But there are two ways of looking at these cells. We may regard them, on the one hand, as morphological units of structure comparable with the single tissue cell, or, on the other hand and following Whitman in his interpretation of the egg cell as an organism, we may regard them as complete organisms performing all of the functions of higher animals. Looked at from this point of view the inadequacy of the cell theory as applied to protozoa is obvious.

In a strictly morphological sense then protozoology includes the study of cell structures homologous with the morphological elements of egg and tissue cells—but these structures are more primitive, more generalized, and, in a sense, more easily correlated with their functions in the cell.

First, as to the structure of protoplasm. We are generally agreed at present that it is inaccurate to speak of any one structure as common to all protoplasm, but many cytologists, amongst whom Bütschli, working chiefly on protozoa, was the first, be-

lieve that the different types are referable to one common generalized type which Bütschli described as alveolar in structure. A simple example of such modification of the alveolar into denser plasm can be easily demonstrated in the protruding pseudopodium of *Amœba proteus*. Here the endoplasmic alveoli become drawn out into ellipsoidal forms, the alveolar walls come together and fuse, forming the characteristic denser ectoplasm. Another good example of the same metamorphosis may be seen in the formation of the temporary membrane which appears between the ectoplasm and the endoplasm of *Actinosphærium eichhornii*.

Second, as to nuclei. The study of protozoan nuclei has taught us that a definite, formed nucleus is not essential for cell life. There are many cases amongst the protozoa where there is no morphological nucleus, but the functions of this organoid of the cell are presumably performed by fragments of chromatin distributed throughout the protoplasm. Such is the case, for example, in *Dileptus gigas*, where each granule at cell division elongates and divides. When formed nuclei are present they are provided with a firm and thick membrane which does not disappear during division as in nuclei of higher animals and plants. The chromatin also, is not arranged in a reticulum as in higher forms, but is usually massed in one or several solid bodies termed karyosomes. These have often been called chromosomes, but such use of the term is incorrect, for these karyosomes in many cases break down into finer granules which are secondarily fused into elements strictly homologous with chromosomes of higher forms. In the protozoa therefore we have abundant material for working out a possible evolution of these important elements of higher cells, from generalized conditions of the parasitic amœbæ to the formation of primitive chromosomes in *Noctiluca* or *Paramecium*. In such primitive forms the number of chromosomes is always greater than in metazoa, more than two hundred having been counted in *Paramecium caudatum*.

Third, as to the centrosome. Cytological study of protozoa gives much more direct evidence of the function of this organ of the cell than does its study in egg or tissue cells. In protozoa it is undoubtedly a kinetic center of the cell in the sense of being the central organ in different types of movements. Many types of Heliozoa, such as *Acanthocystis* or *Sphærastrum*, have a definite central granule in the resting cell. At division periods this divides and forms a spindle; the nucleus is drawn into the nuclear plate and connected by fibers with the divided centrosome, and the outcome is a typical karyokinetic figure. After division the spindle fibers and astral rays grow out from the central granule to form the axial filaments of the actinopodia, which in some species of *Acanthocystis* and *Artodiscus* have a vigorous springing movement. In *Dimorpha* both actinopodia and flagella are present and, both having the same origin, we are led to the conclusion that flagella, in this case at least, are little more than naked axial filaments. Similarly, in various types of flagellates, *e. g., Trypanosoma, Herpetomonas, Crithidia*, etc., the flagellum forms by outgrowth from the centrosome thus proving the intimate connection between the locomotor apparatus of the organism and its centrosome.

In many cases this kinetic center is inside of the nucleus—giving what Boveri called the centronucleus type of nucleus. In such cases the axial filaments of *Heliozoa* abut against the nuclear membrane (*e. g.*, in *Actinophrys, Actinosphærium, Camptonema*, etc.), and during division

the intra-nuclear centrosome divides first. In all cases the kinetic center appears to be formed from chromatin, or at least from nuclear material and seems to be made up of a special kind of nucleoplasm. Frequently, as in *Trypanosoma, Trypanoplasma* and allied forms, the kinetic center emerges from the nucleus as in *Heliozoa,* but is accompanied by a small amount of chromatin thus forming a second nucleus which Woodcock has aptly named the kinetonucleus. Such double nuclei, which, it may be pointed out, are in no way homologous with the dimorphic nuclei of infusoria, have led Hartmann, Nägler, Prowazek and some others to form a special group of protozoa termed the *Binuclearia.* The point of view leading to this artificial group has been ably criticized by Dobell.

Fourth, as to chromidia. Goldschmidt and others of the Munich school have interpreted a number of indeterminate structures of tissue cells as chromidia or granules of chromatin discharged from the nucleus. Waiving the question for the present as to whether such objects are chromidia or chondriosomes of unknown origin, there is no doubt whatever that chromidia of nuclear origin occur in protozoa and play a most important rôle in their vital processes. In rhizopods especially, chromidia are formed during, or prior to, the period of maturity, by nuclear secretion, nuclear dissolution or nuclear fragmentation, the granules becoming individually, or after fusion, the nuclei of conjugating gametes. It thus becomes possible to speak of a special germ plasm in protozoa as distinct from somatic plasm. Such chromidia are to be distinguished from the products of nuclear degeneration which occur under abnormal conditions of feeding or environment and which are more analogous to nuclear degeneration and granulation-tissue formation in higher animals.

There remain many lines of research in protozoan cytology, especially in the direction of maturation and fertilization phenomena, only a few forms having been adequately studied. The enigmatical third division in maturation has evidently some connection with sex, since this division is heteropolar in *Didinium, Paramecium caudatum* and *P. bursaria,* the smaller nucleus migrating, the other stationary, during conjugation. Splendid results lie at the end of patient study in this line of research.

II. THE PATHOGENIC SIDE

The development of this branch of protozoa study was so rapid and so spectacular and seemed to arise so unexpectedly out of a clear field, that many investigators, especially pathologists and other medical men, are inclined to regard it as constituting the whole of protozoology. Up to 1890 only two human diseases were suspected of being caused by protozoa. These were dysentery and malaria. To-day more than fifteen human diseases are known or suspected to be of protozoan origin.

Parasitic amœbæ were first observed in the human intestine in victims of dysentery by Lösch in 1875. He had no hesitation in claiming them to be the cause of dysentery and named the organism *Amœba coli.* Other pathologists, however, soon found similar organisms in the intestines of normal men and Lösch's claim was discredited. Councilman and Lafleur in 1891 found two types of amœbæ, one of which—*A. coli*—was considered a harmless commensal, the other, which they called *Amœba dysenteriæ,* they claimed to be the cause of tropical dysentery. Casagrandi and Barbagallo in 1897 were the first to actually prove that the *coli* form is

harmless. They also suggested the new generic name *Entamœba* for these parasitic amœbæ, believing that the differences between them and free forms like *Amœba proteus* are great enough to justify a generic distinction. In this they were followed by Schaudinn in 1903, who succeeded in causing dysentery in cats by feeding them with isolated cysts of the pernicious type which, ignoring the prior specific name *dysenteriæ*, he called *Entamœba histolytica*. The harmless type he called *Entamœba coli* and confirmed Casagrandi and Barbagallo by repeated experiments on cats and upon himself.

Similarly with malaria a few observations were made prior to 1890, but the most valuable work was done after that date. In 1881 Laveran, a French military doctor in Algiers, discovered organisms in the blood of malaria victims. He announced them as the cause of malaria under the name *Oscillaria malariæ*, this generic name being changed four years later to the more incongruous name of plasmodium by Marchiafava and Celli. Another important point was made by Golgi in 1886, in demonstrating that the characteristic paroxysms of the victim coincide with the simultaneous reproduction of the parasites.

It is impossible here, to give the names of the scores of observers who have added some point or other in connection with these parasitic organisms, or to give credit for the first suggestion as to their mode of transmission. After the facts of transmission were proved, numerous claimants of the honor of first suggesting the possibility of mosquitoes carrying malaria or yellow fever, turned up. Theirs is but an empty honor, however, and I dare say they are entitled to all the glory they can get from proclaiming their clairvoyance from the house tops. We are, however, justified in having no little national pride in the fact that two of our countrymen, Smith and Kilbourne, in 1893 actually proved for the first time the transmission of disease-causing protozoa by blood-sucking arthropods. The honor for their discoveries and patient observations and experiments on Babesia in connection with Texas fever in cattle was not shouted from the ridge pole, but came with the fact that their results were immediately applied to human diseases. To Smith and Kilbourne, then, belong a great part of the credit and honor of paving the way to the present-day control of malaria and sleeping sickness, and the practical extinction of yellow fever in epidemic form.

The repeated suggestions that mosquitoes might transmit malaria were brilliantly proved true by Ross in India in 1897–99, and Grassi, Bignami and Bastianelli in 1898–99 in Italy. The former showed that bird malaria is transmitted only by species of *Culex*, the others, that various types of human malaria are transmitted solely by species of *Anopheles*. Stages in development of the parasites in the mosquitoes were made out by Grassi and others, and the last step was taken in the direction of proof by Schaudinn, who, in 1902, watched under the microscope, the penetration of his own blood corpuscles by sporozoites fresh from the proboscis of an infected mosquito.

The transmission of yellow fever by mosquitoes of the genus *Stegomyia* was proved in 1900–01 by the American commission consisting of Reed, Carroll, Agramonte and Lazear, and so clearly and minutely was the prophylactic routine worked out, that epidemics of yellow fever are now a matter of history. Should one occur in any civilized community, it would surely indicate ignorance or criminal carelessness on the part of the health authori-

ties. The cause of yellow fever, however, is still unknown; when discovered, the cure for the disease will surely follow just as its prevention followed the discovery of its mode of transmission.

After the malaria problems were cleared up, discoveries of other protozoan diseases followed in quick succession. Kala azar, dum dum fever, oriental sore and allied diseases of the far east, were found by Leishman, Donovan, Wright, Christophers, Patton and others, to be due to a flagellated protozoon of the genus *Herpetomonas,* and transmitted by bed bugs.

Sleeping sickness, the great scourge of central Africa, was hunted down by the indefatigable David Bruce in 1903, who showed that it is transmitted by a tse tse fly, *Glossina palpalis.* This discovery followed his brilliant researches of 1894–97 when he traced the cattle disease called "nagana" and the "tse tse fly disease" of cattle to the same protozoon—*Trypanosoma brucei*—and showed that a tse tse fly—*Glossina morsitans*—is the intermediate host. The final observations on human sleeping sickness were possible through the earlier discoveries by Lewis in 1879 on a trypanosome of the rat; by Forde (1901) and Dutton (1902) of a trypanosome in victims of Gambia fever which was regarded up to that time as distinct from sleeping sickness. This organism was named by Dutton *Trypanosoma gambiense.* Also, in 1903, Castellani discovered a trypanosome in the cerebrospinal fluid of victims of sleeping sickness and named it *Trypanosoma ugandense.* Bruce showed that the trypanosomes of the two diseases are the same and that Gambia fever is the initial phase of the fatal disease.

Time does not permit even the naming of other species of trypanosomes found in warm- and cold-blooded animals; nor of the many researches that have resulted in the discovery of intermediate hosts amongst leeches, flies and lice. Much has certainly been accomplished, but there still remains a great and undeveloped field for research in the life histories of the various species.

Perhaps the most spectacular discovery in connection with protozoa and disease was that of Schaudinn in 1905, when in a short publication he announced the discovery of spirochætes in syphilitic lesions. This modest little paper of four or five pages has been the inspiration of thousands of titles, most of which have added little or nothing to Schaudinn's original work, the majority dealing with technical methods, a few with morphological changes and the life history, and a few, notably Robert Koch's, with treatment. Other spirochæte diseases, such as yaws or frambesia, human relapsing fever and tick fever, or diseases of cattle and poultry, have been shown to be transmitted by ticks of one species or other, but *Treponema pallidum,* as Schaudinn finally called the spirochæte in syphilis, is apparently transmitted solely by contact.

One of my students this spring made the comment that most of the references I had given in connection with pathogenic protozoa seemed to fall within the period of 1900–05. The observation was entirely correct and the fact is undeniable that the last five years have given little of value in this branch of protozoology, while in the preceding five-year period not only were the majority of protozoan diseases discovered and their means of transmission established, but that period gave us Mesnil and Mouton's method of cultivating parasitic amœbæ on artificial media, and the brilliant researches of Novy and MacNeal resulting in an entirely new method for the study of parasitic flagellates. Since that period few new discoveries

have been made; culture methods have been extended to the spirochætes and some good observations have been made on the interrelationships of parasitic flagellates and hæmosporidia. In my opinion, however, this branch of protozoology has seen its period of greatest development and, save for the working out of life histories, the protozoologist may well turn over the pathogenic protozoa to the departments of medicine, public hygiene and public sanitation.

In preparing this lecture I was tempted to dwell longer on this interesting and important phase of protozoology and to give a detailed account of the trials and difficulties experienced in establishing the causes of protozoan diseases. Also I should like to speak at length on the probable causes of smallpox, scarlet fever, rabies, trachoma and molluscum contagiosum, and about the many fruitless attempts to trace human cancer to protozoa, but I must hasten on to a third, and, as I believe, the most important, branch of protozoology, general biology.

III. The Biological Side

Here the field of protozoology expands so widely that I can speak of only a few topics, for the problems are fundamental and universal and merge into those which every biologist is striving to solve.

Verworn in 1888 made the statement that protozoa seem to have been especially adapted by nature for the purposes of the physiologist, for here, in the single cell, are performed all of the functions which higher animals perform. This was twenty-three years ago and the fact that strikes us to-day is that, in spite of the vast amount of work done in the subject, these same fundamental vital activities remain almost as obscure as they were then. Some progress, nevertheless, has been made. The early experiments of Balbiani, Verworn, Gruber, Hofer and a score of others demonstrated that enucleate fragments of cells could not secrete, grow nor continue to live, while Verworn in 1891 showed that the isolated nucleus is equally impotent. The axiom was thus laid down that nucleus and cytoplasm are equally important for the proper performance of vital activities.

At this earlier period it was thought that great light would be thrown upon the vital functions of higher animals through study of the simpler activities in protozoa, especially in the directions of (1) digestion and assimilation, (2) irritability, (3) growth and reproduction, (4) regeneration, (5) sex and fertilization, (6) death and physical immortality, etc., but it was soon discovered that under the mask of simplicity lie hidden the same great problems which puzzle biologists in every other field of study. Let me illustrate briefly some of these points.

1. *Digestion and Assimilation.*—The early observations by Le Dantec, Meissner, Fabre-Domergue, Greenwood and others from 1888–1894 demonstrated the presence of some mineral acid in connection with proteid digestion in different types of protozoa, and it was suggested that some simple ferment, acting in an acid medium, is responsible for digestion in these single cells. This suggestion was confirmed by Hartog and Dixon in 1901, who isolated a proteolytic ferment active in an acid medium; but the subject became more complicated when Mouton and Mesnil in 1902–03 isolated a proteolytic ferment that was active in an alkaline medium, and suggested that the digestive ferment in protozoa is more like trypsin than pepsin. Finally, Nierenstein and Metalnikoff, in 1903–07 showed that both types of ferment are involved, digestion beginning with

an acid reaction, followed by an alkaline reaction, and conforming in a general way with the digestive processes in higher animals. Few physiologists have attacked the problem of assimilation in protozoa. Verworn, however, in his "Biogenhypothese," has outlined a theoretical conception of the combination of protoplasm molecules with the products of proteid digestion and based on the Ehrlich side-chain hypothesis.

2. *Irritability.*—Jennings's splendid studies on the behavior of protozoa and lower metazoa have shown that all forms can not be interpreted as simple units of protoplasm reacting to all external stimuli by the same simple reflex. A *Poteriodendron,* on its simple protoplasmic and filamentous stalk, has but the one reaction, contraction of the stalk, but a *Stentor, Vorticella* or *Paramecium* has not only one but several forms of reaction which are frequently so coordinated as to defy analysis. The reactions, furthermore, vary apparently with the physiological state, or, presumably, with physical and chemical states of the protoplasm. Protozoa are thus similar to the lower metazoa and, with them, have been drawn into the field of comparative psychology.

3. *Growth and Reproduction.*—Spencer's theory of growth and reproduction was soon found to be as unenlightening with protozoa as with higher forms and deeper interpretations have been sought. Few have undertaken to formulate any theory of cell division from protozoa alone, but Hertwig in 1902 advanced a physical theory of growth and division based on his protozoa studies, which has had no little influence. This is now known as the "Kernplasmaspannungstheorie," or the nucleus-plasma-tension theory. Briefly stated, this theory is based upon the view that the ratio of nuclear mass to cytoplasmic mass is constant under certain normal conditions of the cell, and may be expressed by the ratio N/P. If either factor is increased without increase of the other, an "abnormal" condition ensues. If the P factor increases, as it does with growth, an increasing tension in the cell results in a disturbance of the nuclear conditions and an incitation to regulation by division. If, on the other hand, the nucleus plasma ratio is changed to the advantage of the nucleus, chromidia formation and cell degeneration are the outcome.

The bare statement of this theory makes it appear crude and infertile, for it is difficult to see how mass relations can be the cause of growth, division or depression, but if we see in the varying ratio of nucleus to cytoplasm only an index of the chemical interchange going on all the time between the several parts of the cell, and interpret such variations as effects rather

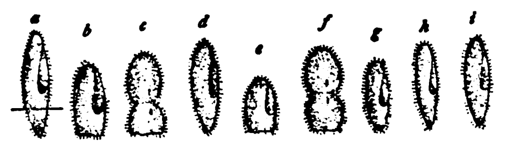

Fig. 1. Absence of regeneration in a cut *Paramecium caudatum.* *a,* normal cell showing plane of cut; *b,* anterior truncated fragment; *c,* division of truncated fragment in original center of cell; *d, e,* normal and truncated cells resulting from this division; *f,* division of second truncated cell.

than as causes, a more plausible explanation of the morphological relations of nucleus and cytoplasm is obtained. That excess of nucleus does not cause degeneration is shown by a simple experiment. If we cut *Paramecium caudatum* as shown in Fig. 1, *a,* the cut cell does not regenerate in the majority of cases, but divides in the original central plane of the organism (*b, c*). As a result of this division one normal (*d,* anterior) and one abnormal (*e,* posterior) cell results. The nucleus

divides equally as though the cell were perfect, hence the posterior cell has a reduced cytoplasm and a full size nucleus, or the ratio N/P is changed to the advantage of the nucleus. Nevertheless, this cell, in some cases at least, grows and divides again without regenerating the lost part and a second abnormal division (f) results in a second abnormal cell and a normal cell. Ultimately, however, the abnormality is lost and the normal form regained. Here, something more subtle than mass relations is at work and we are justified in looking for important results from the further study of protozoa along these experimental lines.

4. *Regeneration.*—The power of regeneration of the cell, also, is much less extensive than we were led to believe by the early experiments of Balbiani, Verworn, Gruber, Hofer, Prowazek and others. It seemed to follow from their experiments that any fragment of a protozoan, provided it contained some nuclear material, would regenerate quickly into a normal cell. Lillie showed that a piece as small as one twenty-seventh of the original animal would develop into a normal *Stentor*. The power to regenerate, however, varies not only in different races of the same species of protozoa, but also in the same cell at different inter-divisional ages. In four different races of *Paramecium caudatum* I have found that in one race only about one per cent. regenerated after cutting; in another about 10 per cent. regenerated; in a third race about 30 per cent. and in a fourth about 90 per cent. Here, then, is a well-marked racial difference in respect to regeneration.

Again, if we cut the large hypotrichous ciliate *Uronychia transfuga* just after division, both fragments will contain parts of the macronucleus, but only the micronucleus-holding fragment will regenerate. If cut from six to eight hours after division the result is the same, although the non-regenerating fragment lives for days. But if we cut the cell just prior to cell division, both fragments regenerate perfectly except for the absence of a micronucleus in one. The power to regenerate, therefore, varies in the same cell from a minimum just after division to a maximum just prior to division, a phenomenon lending support to the view that certain stuffs are accumulated during cell life up to a condition analogous to saturation, when the reaction follows, in this case regenerative processes. With such activity the accumulated stuff is used so that regeneration does not follow mutilation immediately after, or for some time after, cell division. Certainly the generalization that nucleated fragments of protozoa will regenerate is not well founded.

Similarly with other early generalizations. The classic experiments of Maupas seemed to prove that Weismann's theory of the potential immortality of protozoa was wrong. Later research confirmed Maupas in the main, until to-day Weismann's theory, in its original form at least, is untenable, protozoa having the same potential of immortality that metazoa have, no more and no less. Later research, however, has given highly variable results in studies of the life history, and again we find an individuality in different races of the same species. Woodruff's remarkable and enigmatical results with *Paramecium caudatum*, for example, show that earlier conclusions and generalizations were premature.

One general conclusion, however, seems to be well established, viz., that the protozoon's life history runs in cycles of asexual and sexual phases. The beautiful work of Schaudinn in 1899, on the life cycle of *Coccidium schubergi*, gave the model fol-

lowed by subsequent investigators in working out life histories of other forms, and there is no doubt now that the protozoon life cycle involves more or less definite asexual and sexual periods. In parasitic protozoa the sexual phase, including maturation, conjugation and fertilization, undoubtedly leads to renewed vigor of the race, or to a new power of asexual development, and to this extent at least, the time honored view of Bütschli's (1876) that conjugation is a means of the "Verjungung" or rejuvenation of the cell, is warranted.

Associated with these alternate phases in the life history are the remarkable changes which accompany development of the sexual phase. These, involving the problems of sex, are particularly important in connection with the nuclear changes whereby a specific germinal chromatin is formed, sometimes at an early stage, in the asexual phase, and persisting as a germ plasm until used in the formation of gamete nuclei.

I have now given enough of the scope of protozoology to indicate that the protozoologist, far from being a strict specialist, rather immodestly claims the greater part of the whole field of biology as his own, and I would define protozoology, therefore, as that branch of the biological sciences which deals with the application of biological problems to, and with search for their solution in, the lowest group of animal organisms—the Protozoa.

Gary N. Calkins

SYNTHETIC METALS FROM NON-METALLIC ELEMENTS[1]

It is one of the most striking facts of chemistry that three fourths of all the elements are metals. But it is no less remarkable that metallic properties are confined exclusively to elements in the free state or, in case of alloys, to combinations of typically metallic elements.

In recent years the theory of the nature of the metallic state has been steadily developing into more and more precise form, so that to-day we have, in the electron theory of matter, a very satisfactory explanation for all of the characteristic properties of metals. Inasmuch as it is just a century since Davy proposed his celebrated metallic ammonium theory, we may now well consider whether metallic properties are, of necessity, confined to elements in the free state.

During the last two decades a vast amount of experimental evidence has been accumulating that electricity is granular in structure, though such a conclusion was strongly indicated three quarters of a century ago by Faraday's discovery of the facts epitomized in the law of electro-chemical equivalents as first pointed out by Helmholtz in 1881. The granules or ultimate atoms of electricity are now called corpuscles or electrons. The charge of the electron is negative in sign. In fact we have decisive experimental evidence of only this one kind of free electricity, positive electrification of a body, being from this standpoint merely a deficiency of electrons.

J. J. Thomson has shown how from the conception of an atom made up of electrons rotating in a sphere of positive electrification, there follows a simple explanation of many of the properties of an atom, including valence; a univalent atom, if negative, being one that can gain an electron, if positive, one that can lose an electron. A bivalent can gain or lose two electrons. A trivalent atom, three, etc. According to this hypothesis the most fundamental property of an atom of an element is this

[1] Read at the meeting of the American Chemical Society, Minneapolis, December, 1910.

tendency to gain or lose one or more electrons. The tendency to lose electrons is greatest for the alkali metals and least for the noble metals. According to this view, for example, sodium and chlorine react with great energy because of the great tendency for each atom of free sodium to lose an electron, on the one hand, and each atom of free chlorine to take up an electron, on the other. The action consists, therefore, in the transfer of an electron from an atom of sodium to an atom of chlorine. The components of a molecule of solid salt are therefore not an *atom* each of sodium and chlorine, but an *ion* of sodium combined with an *ion* of chlorine, if by the term *ion* we now mean atom $\pm$ an electron.

The more or less complete "electrolytic dissociation" or "ionization" which occurs upon dissolving a salt in water is then due to the marked lessening of the electric force which holds together the ions of the solid salt by reason of the very great dielectric constant of water.

The application of the electron theory to the metallic state by Riecke, Drude, Lorentz, Thomson and others has led to results of the highest significance. Though the details of the relations of the electrons to the atoms are viewed somewhat differently by different physicists, it is however agreed by those who are working in this field that metals owe their most characteristic metallic properties of a physical nature to the *mobile* or free electrons which they contain. The absence of metallic properties in the solid non-metallic elements is, by this hypothesis, due to the supposed tendency of the atoms of such elements to *gain*, not lose, electrons: for which reason such a non-metallic solid will contain very few free or mobile electrons.

Thus, according to one view, electrons which are perhaps as numerous as the atoms of the metal, move about freely among the atoms, with which they are considered to be in kinetic equilibrium. Electric conductivity is then due to the drift of these electrons under the influence of the potential in the wire. Thermo-conductivity of metals is explained equally satisfactorily by the electron hypothesis. The calculated ratio of thermal to electrical conductivity and also the temperature coefficient of the ratio are in good agreement with the facts. Other metallic properties, including opacity to light, reflecting and radiating power, the Hall effect, the Thomson effect, the Peltier effect, etc., are equally well accounted for.

The most characteristic chemical property of a metal is its ability to form the positive ions of salts. Every true metal has this property well developed. If we electrolyze a solution of a salt, say silver nitrate, the free positive ions of silver are attracted and move toward the negative electrode; on coming in contact with which each ion has forced into it an electron, which converts it into an atom of silver. The aggregate of such atoms deposited on the cathode has metallic properties; owing to the great tendency of each atom to give up an electron.

When we come next to consider the behavior upon electrolysis of a salt of a compound basic radical, it is difficult to see wherein its behavior should differ from that of a salt of a metallic element. In this case, as in the other, positive ions are attracted to the cathode, and upon striking the latter can gain electrons. If then the electron theory of the metallic state is as fundamental as it seems to be, the aggregate of such free "neutralized" radicals should be a body having metallic properties; in other words, a "synthetic metal." For such a hypothetical body would be made up of radicals, which, analogous to

metallic atoms, could easily lose electrons. The mass would then contain an abundance of mobile or free electrons and in such case possess high electrical and thermal conductivity, metallic luster, etc.

Turning now from theory to facts, the case of ammonium amalgam demands consideration at once on account of its historical importance. This remarkable substance was discovered practically simultaneously and independently by Seebeck, and by Berzelius in 1808; curiously enough, in just the same year that Davy isolated sodium and potassium from their hydroxides. Two years later Davy, in 1810, compared ammonium amalgam with the amalgams of sodium and potassium and was led to announce his famous ammonium hypothesis; the radical ammonium was analogous to the alkali metals and was said to exist in metallic form, united with the mercury, in ammonium amalgam. Berzelius and Ampere also supported this view. Some years later, after the discovery of other radicals, Dumas and Liebig in a joint paper gave Davy's idea a much more general form. They wrote: "Organic chemistry possesses its own elements which sometimes play the part of chlorine or oxygen, sometimes, however, also, that of a metal. Cyan, amid, benzoyl, the radicals of ammonia, the fats, the alcohols and their derivatives, form the true elements of organic nature." But the hypothesis of the metallic nature of ammonium in the amalgam did not pass unchallenged. Gay-Lussac and Thenard concluded that the so-called amalgam is only a mixture of ammonia, hydrogen and mercury; a view subsequently shared by many others, among them Seely, who found the volume of the inflated mass to be inversely proportional to the pressure upon it. The case against the metallic ammonium hypothesis was made still stronger by the evidence furnished by an experiment by Landolt in 1868. If the amalgam is really analogous to sodium amalgam, if the radical actually has the properties of a metal, it should readily precipitate from solutions of their salts metals of smaller solution tension; but, in the test, Landolt could precipitate neither copper nor silver with ammonium amalgam.

The first really convincing evidence in favor of the ammonium hypothesis was furnished by LeBlanc in 1890. LeBlanc electrolyzed a solution of an ammonium salt with a mercury cathode. The apparatus was so arranged that simultaneous measurements of the polarization potential could also be made. This potential rose in a few minutes to a maximum which was nearly as great as that given by a sodium salt. The really important result, however, was observed after the polarizing current was cut off. The mercury cathode, which showed the inflation characteristic of ammonium amalgam, was still strongly electro-negative toward the solution and remained so for from ten to twenty minutes. That this effect was not due to hydrogen was shown by the fact that the hydrogen polarization potential was considerably smaller and that it fell off almost as soon as the current was interrupted. These experiments of LeBlanc, based as they were on the sound principles of electro-chemistry, gave a new impetus to the ammonium hypothesis. Coehn, in 1900, reasoned that if ammonium amalgam gave the high potential found by LeBlanc, it surely ought to precipitate copper and silver, and that Landolt's experiments should succeed. But Coehn failed exactly as did Landolt! Coehn next found that at very low temperatures, or even at zero, the amalgam was much more stable than at room temperature, and would precipitate copper from copper sulphate without difficulty.

This result was in itself insufficient to prove the metallic nature of ammonium, since free hydrogen was always present in the amalgam, and may have been the active substance in the reaction. To remove any doubt, Coehn then showed that not only are cadmium and zinc precipitated by the cold amalgam, but that barium amalgam results from the action at zero of ammonium amalgam on a solution of barium chloride. This fact was independently discovered later by G. M. Smith, who also obtained sodium and potassium amalgams in a similar manner. Thus the experiments of LeBlanc, Coehn and G. M. Smith furnish indisputable evidence of the metallic nature of ammonium in ammonium amalgam.

It is often stated that metals are insoluble in a physical sense, in all solvents excepting other metals. This statement can scarcely be upheld in view of the recent work of Kraus, on solutions of sodium, potassium, calcium, etc., in liquid ammonia. These very unique solutions, discovered by Weyl in 1864, seem to have many distinctive metallic properties. They are practically opaque, except when very dilute; even in this respect they resemble gold, which is transparent in very thin layers. They also show metallic luster, and reflection, and while they conduct the electric current, the conduction seems to be metallic rather than electrolytic in character. Upon evaporation, they deposit the pure metal in crystalline form. All such solutions, if sufficiently dilute, have a characteristic deep blue color. Now Palmaer has shown that by the electrolysis of tetraalkyl ammonium salts dissolved in liquid ammonia, unstable blue solutions are formed about the cathode. These blue solutions were thought to contain the organic radical in metallic form dissolved in ammonia. These facts have been confirmed by Kraus, who also concurs in the explanation.

LeBlanc's experiments on the polarization of mercury in solutions of ammonium salts, were also extended to include a similar study of salts of a number of substituted ammonias. Mono-, di- and tetramethyl and mono-ethyl ammonium ions gave results more or less like those of ammonium ions, from which facts LeBlanc concluded that in these cases also amalgams were formed, although none of the supposed amalgams were isolated. When attempts were made by Dr. Moore and myself to obtain an amalgam by the electrolysis of aqueous solutions of tetramethyl ammonium salts the results were complete failures; not a trace of amalgam could be isolated. But when we substituted absolute ethyl alcohol for water, as solvent, the amalgam resulted at once.[2] This amalgam differs greatly from ammonium amalgam in both appearance and stability. It is a crystalline solid of metallic luster, closely resembling sodium amalgam. It can be kept for days at temperatures below $+10$ degrees and does not have any tendency to become inflated. Its density is somewhat less than that of mercury, but still many times greater than that of ammonium amalgam. Its electrical conductivity is comparable to that of a metal. Chemically, it resembles the alkali metal amalgams, but is far more active than that of sodium. It reacts with water with great energy and rapidity, giving hydrogen and the corresponding base, tetra-methyl ammonium hydroxide. From solutions of salts of copper and zinc, these metals are precipitated at once; while from solutions of salts of sodium and potassium the corresponding amalgams are formed. With solutions of ammonium salts the charac-

[2] McCoy and Moore, Science, **30**, 315 (1909); *J. Amer. Chem. Soc.*, **33**, 273 (1911).

teristic inflated mass of ammonium amalgam is produced.

The very high electrolytic solution tension indicated by these reactions is confirmed by direct potential measurements. The values obtained, for similar conditions, are about .6 volt higher than those found recently by Lewis and Kraus for sodium amalgam. This result is in harmony with the enormously greater activity towards water of the organic amalgam. Dr. Moore and I have also made mono-methyl ammonium amalgam and studied its properties.

The facts just discussed point clearly to the probability that in general positive ions, if free, or even amalgamated with mercury, will possess metallic properties. Practically, however, several causes may prevent the isolation of such metallic bodies. We know that it is not possible by electrolysis to separate many metals like sodium from aqueous solutions of their salts. Similar relations may obtain in the electrolysis of an organic salt. On the other hand, it is theoretically possible that such a compound metal may be so unstable in the free state that it suffers spontaneous decomposition at the moment of its formation from its ions. A third possibility is exemplified by the case of hydrogen. For a long time it was thought by some chemists that hydrogen in solid form would have metallic properties, since acids may be considered "hydrogen salts." The fact that solid hydrogen is now known to have no metallic properties proves clearly the fallacy of the old idea and seems to be also a flat contradiction of the hypothesis in question.

Now, hydrogen differs from the metals in one other important respect: while the molecules of metallic vapors are always monatomic those of hydrogen are diatomic. Thomson has considered the question of the theory of the union of two like atoms to form a molecule of an elementary gas, and has shown very convincingly that it is reasonable to conclude that one atom sends its valence electron into the other and that the combination is entirely analogous to that when two unlike atoms combine. If this is the case, it is possible to understand why solid hydrogen has no metallic properties; its valence electrons are *bound* and not *free* nor *mobile*. Analogously to hydrogen, some organic radicals which can form positive ions of salts may unite in pairs to form double radicals. These would not be expected to have metallic properties.

In some cases, however, even hydrogen seems to have some metallic properties; it dissolves readily in palladium and, when nascent, diffuses easily through iron. The latter property of hydrogen may be due to continued existence in the monatomic and therefore metallic state.

As I have tried to point out, the electron theory of the metallic state would lead us to expect that free radicals, formed by the neutralization of the positive ions of salts by the introduction into each ion of that number of electrons represented by its valence would have metallic properties. The facts just reviewed, though few in number, seem to me to lend support to this hypothesis, and to lead to the conclusion that it is possible to prepare composite metallic substances, which may be termed synthetic metals, from constituent elements, some of which at least are non-metallic.

Herbert N. McCoy

December 28, 1910

WILLIAM RUSSELL DUDLEY.

William Russell Dudley, professor of systematic botany in Stanford University, was born on a farm in North Guilford, Conn.,

on March 1, 1849, and died at Los Altos, Cal., on June 4, 1911.

The fact that the writer has been intimately associated with Professor Dudley since the day he entered the freshman class at Cornell University, in September, 1870, will perhaps excuse the personal element in this little sketch.

The word "instructor" as a technical term, describing a minor assistant to a professor, had just then been invented, and the present writer had just been appointed "instructor in botany" under Professor Albert N. Prentiss.

One day, Professor Henry T. Eddy, now of Minnesota, brought to me a tall, well-built, handsome and refined young man, older and more mature than most freshmen, and with more serious and definite purposes. Young Dudley had an intense delight in out-door things and especially in flowers and birds. He wanted to be a botanist, and had turned from old Yale, to which as a descendant of Chittendens, Griswolds and Dudleys he would naturally have gone, to new Cornell, because Cornell offered special advantages in science, and because at Cornell a good man could, if need be, pay his own way. For the rest of my stay at Cornell, Dudley was my room-mate, living in a cottage on the hill, built by students and termed "University Grove." In this cottage was established the boarding-club, known later and appropriately as "The Struggle for Existence," and in later and more economical times as the "Strug." For a time, Dudley paid his way by rising at four o'clock to milk cows at the farm. Later he was made botanical collector, and this congenial work he kept up until he became my successor as instructor in botany. In college Dudley was a member of the Delta Upsilon fraternity, and took an active part in holding this society to the high ideals (dikaia upotheke) on which it was originally based. He was also a charter member in the honorary scientific society of Sigma Xi (spoudon xunones).

In 1871 I went with him to his home at North Guilford, and I remember that his practical father said to me:

> There comes Willie across the fields with his hands full of flowers, just as he used to. I wonder if there is any way he can make a living by it.

Dudley graduated from Cornell in 1874, with the degree of B.S. In 1876, he received the degree of M.S., after which he spent some time in botanical study in Strassburg and Berlin. From 1872 to 1876 he was instructor in botany at Cornell, his eminent knowledge of the eastern flora overbalancing the fact that at first he had not yet received a degree. From 1876 to 1892 he was assistant professor of botany at Cornell, with a year's absence in 1880, in which he served as acting professor of biology in the University of Indiana, in the absence of the present writer, who then held that chair.

In 1892, Professor Dudley became professor of systematic botany at Stanford University, which position he held until, in January, 1911, failing health caused his retirement on the Carnegie Foundation as professor emeritus, his work being then taken by one of his students, Associate Professor Le Roy Abrams.

Many of the leading botanists of the country have been students of Professor Dudley. H. E. Copeland, Kellerman, Lazenby, Branner were among his associates at Cornell. Atkins became his successor at Cornell. Abrams, Cook, Elmer, Olssen-Seffer, Cannon, Wight, E. B. Copeland, E. G. Dudley, Greeley, Herre, McMurphy and many others were under his tutelage at Stanford.

In Stanford University, Dudley was one of the most respected as well as best beloved members of the faculty. No one could come near to him without recognizing the extreme refinement of his nature; a keen intellect, an untiring joy in his chosen work, and the Puritan conscience at its best, with clear perceptions of his own duties to himself and a generous recognition of the rights and the aspirations of others.

Dudley entered with great joy into the study of the California flora. He became especially interested in the study of trees, the evolutionary relations of forms and especially the problems of geographical distribution.

The conifers of California were his special delight, and he made many field trips with his students to all parts of the state, notably to the Sierra Nevada and the Sierra Santa Lucia. His extended collections were presented to Stanford University, where with the collections of Dr. Abrams they form the major part of the large "Dudley Herbarium."

A genus of stone-crops, of many species, abounding on the cliffs of California and especially on those which overhang the sea, was named *Dudleya* by Britton and Rose. *Dudleya pulverulenta* is one of the most conspicuous plants in California wherever "sea and mountains meet."

Dudley was instrumental in inducing the state of California to purchase a forest of redwoods (*Sequoia sempervirens*), that this, the second of California's giant trees, might be preserved in a state of nature. Two thousand five hundred acres in the "Big Basin" of Santa Cruz County were thus bought and established as the "Sempervirens Park." For several years Dudley served on the board of control of this park.

Of the Sierra Club of California, Dudley was a leading member and for some years a director.

As an investigator, Professor Dudley was persistent and accurate, doing his work for the love of it. A partial list of his papers is given below. A large work on the conifers of the west was long projected, but still exists only in uncompleted manuscript.

Dudley was master of a quiet and refined but effective English style. He was one of those scientific men, too few I fear, who have real love for literature, and who understand what poetry is and what it is about. In his early days he wrote graceful verse. Three of his poems are in print, "The Kaaterskills as seen from the Taeonics," "Sunrise on the Kaaterskill" and "A Legend of the Lehigh Valley." The last is the story of the Moravian settlements of "Friedenhütten, Tents of Peace, and Gnadenhütten, Tents of Grace."

From the first of these, I quote:

'Twas reached at last, with toiling long and weary
  Taconic's loftiest hill;
Then, vision of all visions, stood uncovered
  The domes of Kaaterskill!

They rose above the lesser hills as sovereigns
  Above the common herd;
They gathered then in conclave grand and solemn;
  They breathed no spoken word.

But full as anthemed voices of the ocean
  A soundless song was borne
Up from those lips that changeless through the ages,
  Sang on Creation's morn.

. . . .

A mighty calm sits on these silent summits,
  Time fades, as breath away,
O'er all in solemn oceanic pulsings
  Deep flows—Eternity.

From the "Legend of the Lehigh Valley," I quote the last verses:

Full six score years have passed away.
  Still on the silent summer morn,
At noon's repose, or evening's gray,
  O'er Lehigh's vale this dirge is borne.
    The reaper hears, on far-off hills,
    And traveler by the mountain rills,
    And fisher in the evening's chills;

They hear and feel some echo wake
  Of sorrow slumbering long. A tear
Is shed for some sweet lost one's sake,
  A tear that leaves life's stream more clear.
    They bless the song and them who sing;
    They feel the sympathy upspring
    That's born of human suffering.

The air is full of sad-toned bells
  That never cease their brazen toll;
With circling suns their pulsing swells,
  And in one tireless world-wave roll.
    But grateful unto sorrow's ear
    From the Lehigh, far or near,
    Comes this dirge so sweet and clear,—
    Come these human voices dear.

Professor Dudley's health was good until about three years ago, when he set out to study the trees of Persia. In Egypt he was attacked by a severe cold or bronchitis which ended in tuberculosis.

He was never married.

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DAVID STARR JORDAN

PROFESSOR WHITMAN'S COLLECTION OF PIGEONS

BIOLOGICAL investigators will be glad to know that the large and valuable collection of pigeons and birds which were the basis of nearly a score of years' work of the late C. O. Whitman are being maintained and kept together. The material upon which Professor Whitman's extensive evolutional and natural history investigations were made will thus be available while his manuscripts and records are being arranged for publication.

Very abundant material is at hand for a continuance of studies on hybridization, sex, fertility, instinct, etc., more than is now utilized to its full advantage.

Mrs. Whitman has arranged, as long as it is utilized, to keep together this material, priceless from its history, some of the birds having pedigrees reaching back for a long series of years. The collection has been gathered from all parts of the world, not only through long years which consecration to the work could alone have made possible, but also at great expense of money which could be made use of only through sacrifice. Those

who know best what this has been feel that the collection must be kept to be utilized as long as it will serve its purpose.

It was only in the last months of Professor Whitman's life that facilities for experiments and observation on a much larger scale were secured through the efforts of friends who put at his service the piece of ground adjoining his residence. He at once had built a large number of new cages; and delighted with the prospect of the enlarged opportunities declared that his real work he was just about to begin and that "five years will show."

For these reasons and because Professor Whitman's work became more illuminating as he went on, his family and friends feel that the opportunities so untimely left should be extended to others who wish them. Quarters are also given in the residence alongside the nearly one thousand birds, and Dr. Riddle, now at work with them, will cooperate with the work of others, or assist, or direct, as needed.

The library, which is one of the largest and most complete of biological libraries, is held open for constant use. The volumes are very extensively marked; pencil notes often bringing together from all quarters the various facts bearing on the subject under discussion.

SCIENTIFIC NOTES AND NEWS

THE divisions of vertebrate and invertebrate paleontology and paleobotany in the U. S. National Museum have been combined into a new division of paleontology, with Dr. R. S. Bassler as curator in charge, Mr. J. W. Gidley as assistant curator of fossil mammals and Mr. Charles W. Gilmore, as assistant curator of fossil reptiles.

THE presidents of the sections of the fifteenth International Congress on Hygiene and Demography to be held in Washington from September 23 to 28, 1912, are: (1) Hygiene microbiography and parasitology, Professor Theobald Smith; (2) Dietetic hygiene, Hygienic physiology, Professor R. H. Chittenden; (3) Hygiene of infancy and childhood and school hygiene, Dr. A. Jacobi; (4) Industrial and occupational hygiene, Dr. G. M. Kober; (5) Control of infectious diseases, Dr. Hermann Biggs; (6) State and municipal hygiene, Dr. Frank F. Westbrook; (7) Hygiene of traffic and transportation, Dr. W. Wyman; (8) Military, naval and tropical hygiene, Dr. H. G. Beyer; (9) Demography, Professor Walter J. Willcox.

THE Paris Academy of Sciences has elected as foreign members Dr. Zaboudski, of St. Petersburg, in the section of mechanics, and Professor Perrincito, of Turin, in the section of agriculture.

WE learn from the *British Medical Journal* that in recognition of Sir Patrick Manson's initiative in directing attention to the importance of the study of tropical medicine and of his work in that field of science, an international committee has been formed for the purpose of presenting him with a gold medal bearing his effigy. The medal is to be designed by Dr. Paul Richer, of Paris, who is eminent both as an artist and as a physician.

THE annual meeting of the Society of Chemical Industry was held in July at Sheffield, under the presidency of Mr. Walter F. Reid. Dr. Rudolf Messel, of London, was elected president for the ensuing year.

WE learn from the *Journal* of the American Medical Association that a meeting of the members of the Pennsylvania Pharmaceutical Association, Philadelphia Association of Retail Druggists, Philadelphia Branch of the American Pharmaceutical Association and its scientific section, Philadelphia Branch of the American Chemical Society, Philadelphia College of Pharmacy, etc., was held in Philadelphia on July 17 at which strong and vigorous protests were made against the suggested removal of Dr. Wiley; a preamble and resolutions were adopted and sent to President Taft, endorsing and commending Dr. Wiley's work and deploring any movement which would either cause Dr. Wiley to resign at this time or would tend to hamper him in his efforts to make the Food and Drugs Act effective, and thus practically render it a dead letter.

DR. LEONHARD STEJNEGER, head curator of the department of biology, U. S. National

Museum, has been designated as the representative of the Smithsonian Institution at the celebration of the one hundredth anniversary of the founding of the Royal Frederick University, to be held at Christiania, Norway, September 5 and 6, 1911. Dr. Stejneger will also represent the institution at the celebration of the five hundredth anniversary of the founding of the University of St. Andrews, which will occur from September 12 to 15, 1911. Dr. Stejneger is a graduate in arts, philosophy and law of the University of Christiania.

DR. A. S. PEARSE left the University of the Philippines on August 1, and has returned to the United States.

DR. M. C. SMITH, of Lynn, Mass., has sailed for Europe, where he expects to study the relation of the thyroid gland and the pituitary body to the development of the teeth and mouth, and to attend the meeting of the French Congress of Stomatology, and the meeting of the British Dental Society.

DR. G. W. CRILE, of Cleveland, Ohio, spoke to the physicians of San José, Cal., in the San José high school on July 7 on the subject of "Surgical Shock."

THE German central committee for cancer research has issued an appeal to create a foundation which is to be known as the Ernst v. Leyden foundation for cancer research and repression.

THE French Physical Society and other societies propose to collect a fund to honor the memory of the late M. J. Joubert, of the Pasteur Institute. The object of the fund is to found a scholarship, tenable at one of the institutions with which he was connected as pupil or teacher.

DR. JOHN BEDDOE, F.R.S., a practising physician who has made important contributions to anthropology, died on July 19, aged eighty-four years.

DR. W. SPRING, professor of chemistry in the University of Liège, died on July 17.

DR. CHARLES NÉLATON, vice-president of the French Surgical Society, died at his home in Paris on July 23.

BY the will of the late Charles S. Chase $100,000 is bequeathed to the Harper Hospital, Detroit. The income is to be used for the establishment of free beds and for the offering of prizes for research work looking toward the cure of cancer.

DR. L. D. MASON, of Brooklyn, vice-president of the American Society for the Study of Alcohol and other Narcotics, offers a prize of $150 for the best essay on "The Biological and Physiological Relations of Alcohol to Life." The essay must contain original research on the inherited effects of alcoholic degeneration. It must be sent to Dr. T. D. Crothers, Hartford, Conn., before July 1, 1913.

AN exposition of inventions, the first to be held in America, will open at St. Louis, on September 11. It is intended for the exhibition, demonstration and promotion of patented machines, appliances, devices, tools and processes of every character. Further information may be obtained from the manager, Mr. F. W. Payne, St. Louis Coliseum Company, St. Louis, Mo.

DURING the week of August 20–27, there will convene in Antwerp, Belgium, the seventh International Esperanto Congress, in which over 2,000 delegates from every country of the world, will take part, all using one common tongue, the international auxiliary language Esperanto. In addition to the regular Esperanto delegates, several nations will be represented by official government delegates. Mr. Edwin C. Reed, of Washington, secretary of the Esperanto Association of North America, has been apppointed by the Secretary of State to represent the United States.

WE learn from *Nature* that a meeting of the British Institution of Mechanical Engineers was held on July 25 and 26, at Zürich in the Swiss Polytechnikum. Among the papers on the program were: "Electric Traction in Switzerland," by Mr. E. Huber-Stockar, of Zürich; "Results of Experiments with Francis Turbines and Tangential (Pelton) Turbines," by Professor Franz Prášil, of Zürich; "Some New Types of Dynamometers," by Dr. Alfred Amsler, of Schaffhausen; "Rackrail-

way Locomotives of the Swiss Mountain Railways," by Mr. T. Weber and Mr. S. Abt, of Winterthur; "High-pressure Water-power Works," by Mr. L. Zodel, of Zürich.

THE preparations for the Australian Antarctic expedition are, Reuter's Agency learns, practically completed, and the expedition ship *Aurora,* under the command of Captain Davis, left the Thames at noon on July 25. Only two members of the staff of the expedition will go out in the ship—viz., Lieutenant Ninnis, assistant surveyor, and Dr. Mertz, zoologist. All told, the officers and crew of the *Aurora* will number 25; they will throughout remain with the ship. The bulk of the stores for the expedition is going out by the *Aurora,* which will also take the 48 dogs secured in Greenland, 30 sledges built in Norway and a very extensive oceanographical equipment which has been lent to the expedition by the Prince of Monaco. The monoplane built for the expedition by Messrs. Vickers is now being tried at Brooklands, and will be sent by mail steamer to Australia.

A CABLEGRAM from Sydney to the London *Times* reports that one of the northern territory scientific expeditions has left the railway at Pine Creek *en route* for the Roper River. It formed an imposing cavalcade, with its four heavily laden buckboards, 50 horses, donkey-wagon and team, and many camp attendants. Professor Baldwin Spencer has made valuable observations on the natives of the Adelaide River Plains and Melville Island. Mr. Gilruth, the microbiologist, has shot buffaloes, all free from the cysts found in Australian beef; Dr. Breinl, the expert in tropical diseases, has been testing the blood of white children of the third generation. Dr. Woolnough has examined the geological features of the mining fields. Another expedition under Captain Barclay is safe at Newcastle Waters, and intends to follow the course of the McArthur River to the Gulf of Carpentaria, opening up stock routes.

THE work of the U. S. Geological Survey shows no lessening in conservation activities. During the month of June the land-classification board of the survey appraised 174,910 acres as coal land in the western states, placing a valuation thereon of $3,239,369. At the minimum price under which these lands could have been sold before the present regulations were in force, this same area would have brought only $1,392,179. During June the survey also classified 1,415,415 acres as noncoal land and transmitted the findings to the General Land Office so that the land might be restored to the public domain. These classifications were based on the field examinations of the survey geologists. There have now been classified under the present administration, in 40-acre tracts, 16,873,370 acres as coal land, with the valuation of $711,992,537. The valuation of these same lands at the minimum prices would have been $266,652,431, the difference in favor of the government under the present policy being therefore $445,340,106. During the same period 39,215,844 acres have been classified as noncoal land and restored to the public domain. In June three new withdrawals of supposed coal land were made in North Dakota and Wyoming, embracing 714,923 acres, and four restorations were made in Idaho, Montana, Utah and Wyoming, aggregating 1,847,264 acres. In connection with the classification of oil land, the secretary of the interior withdrew in June 170,333 acres in Wyoming, making a total of 3,970,429 acres of oil land now standing withdrawn and awaiting needed legislation in the interests of the conservation of the nation's extensive petroleum deposits. In administration of the phosphate lands 149,129 acres found not to contain phosphate deposits were restored to entry, leaving a total of 2,399,416 acres of phosphate land standing withdrawn and also awaiting necessary legislation. The tonnage of these important deposits has been conservatively estimated at over two billion tons of high-grade phosphate rock. Of land available for the development of water power 10,019 acres were withdrawn during the month by the secretary of the interior, making a total of 1,515,423 acres, including thousands of water-power sites, standing withdrawn in aid of proposed legislation which shall allow for

their development and yet protect the interests of the public.

The *Medical Record* states that the specimens added to the Hunterian Museum during the last twelve months include an important collection illustrating cancer in mice, presented by the Imperial Research Fund. Sir Henry Butlin has given his drawings showing the appearances of this disease and conditions which may be mistaken for it. The tuberculosis commission has given a series of specimens showing the experimental production of that disease. Additions have also been made to the pathological and gynecological collections.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. John G. Archbold has made a further gift of $40,000 to Syracuse University.

Governor Dix has approved two bills passed by the recent New York Legislature, one appropriating $140,000 for the Oswego Normal School, and one appropriating $50,000 for an Agricultural College, Cobleskill.

Upon recommendation of President Hutchins, of the University of Michigan, a committee consisting of three members of the board of regents, and five members chosen from the literary, medical and engineering faculties, has been appointed to make recommendations concerning a thorough reorganization of the graduate school. Also upon the president's recommendation, a resolution has passed the board of regents which makes it the duty of the committee of the board for each department acting with the president and the dean of the department to examine into the record of each member of the teaching force not later than February of each year "with a view of ascertaining what each member of said force is accomplishing in the field of his specialty, and as to the effectiveness of each as an instructor. The object is that the board may have the data for its guidance and information in regard to the question of promotion and retention in service of the members of the different faculties."

The medical school in Shanghai will open its doors in February, 1912, under the auspices of the Harvard Medical School. Dr. Martin R. Edwards will be the head and will have a corps of fifteen assistants, most of them Harvard graduates.

The following changes in the teaching force of the medical department of the University of Pennsylvania are announced in the *Journal* of the American Medical Association: Dr. G. T. Thomas to be associate professor of applied anatomy; Dr. George William Norris to become assistant professor of medicine in place of the late Dr. Aloysius O. J. Kelly; Drs. Joseph Rex Hobensack, William E. Quicksall, Penn-Gaskell Skillern and Nate Ginsburg to become assistant demonstrators in anatomy; Dr. Oscar H. Plant to become demonstrator of pharmacology; Dr. James H. Austin, demonstrator in pathology, to become associate in research medicine; Dr. A. B. Eisenbrey, associate in research medicine, to become instructor in surgery; Dr. James S. Hickey, absent on leave, will resume duty as assistant in physiology.

Professor J. I. D. Hinds, of the Peabody College, Nashville, has been elected professor of chemistry at Cumberland University.

Dr. Herman M. Adler has been appointed instructor in mental diseases at the Harvard Medical School, and will be no longer officially connected with the department of pathology or neuro-pathology. He will retain the position of pathologist at the Danvers State Hospital.

At the New Mexico College of Agriculture and Mechanic Arts Mr. H. S. Hammond, assistant professor of biology, has been advanced to be associate professor and acting head of the department to fill the vacancy caused by the resignation of Professor E. O. Wooton, who enters the government service. Mr. D. E. Merrill, of the State University of Iowa, has been appointed assistant professor in the department.

Mr. Augustus L. Barker, M.Sc. (Alabama), has been appointed instructor in biol-

ogy in the University of Alabama to take the place recently vacated by Mr. James J. Durrett.

Dr. F. B. Dains has resigned the professorship of chemistry in Washburn College to accept an associate professorship of chemistry, in charge of organic chemistry in the University of Kansas.

Professor Karl Pearson, F.R.S., has been appointed to be the first occupant of the chair of eugenics in the University of London, established by the legacy bequeathed for that purpose by the late Sir Francis Galton.

Dr. Erhard Schmidt, professor of mathematics at Erlangen, has been called to Breslau.

DISCUSSION AND CORRESPONDENCE

THE AIR WE BREATHE IN BUILDINGS

To the Editor of Science: In a recent number of Science Dr. Gulick asks several questions with regard to the behavior of aqueous vapor in the air, and particularly as to the reason why air when heated becomes drier. All of his questions could be answered by any competent physicist, or could be resolved by reference to any good text-book of physics or of meteorology. But unfortunately, in these days of over-specialization, the language is apt to be too technical, or in the text-books the information too scattered, to be readily found and comprehended by the general reader. Hence the following explanations may be of some use to him and others in a like position.

There are two popular misconceptions, which it is necessary first to dispel. To begin with, few people seem to understand why water is wet. They think, moreover, that because *water* is wet, the same is true of ice and of aqueous vapor. Now this is not the case. Both ice and aqueous vapor are themselves *dry*. They *become* wet, only when they turn to water, ice when it melts, aqueous vapor when it condenses. Hence of the three water is alone wet, and all real moisture is due to the presence of water. So dry is aqueous vapor that it will dry any moist object that it comes in contact with, just as would superheated steam or a dry gas, which in fact are only other names for the *same* thing. Only, we give the name superheated steam to the vapor when the temperature and pressure are much above those of the atmosphere, as in the case of a steam boiler. Of course we must distinguish between the vapor itself, which is a true gas, dry and transparent, and the cloud or mist into which it condenses, on issuing from a locomotive. Hence it is, strictly speaking, incorrect to talk of the moisture or humidity in the air. There never is any moisture or humidity in the air, unless it be such cloud or mist. The described fallacy therefore consists in identifying things which are different, and distinguishing things which are the same—identifying moisture, humidity and water vapor—and distinguishing water-vapor, superheated steam, and dry gas—which are the same.

The second misconception consists in speaking of the *air* as moist or dry—an error not likely to be dispelled by the language of the text-books, which include sections on the "Hygrometric Condition of the Atmosphere." Dr. Gulick falls victim to this misconception when he seeks to explain the apparent drying of the air on heating as due to some *action* of the air on the contained moisture. Thus he says (p. 327), that on heating the air from 32° to 70°—"It appears that one of two things must have happened—either the heat must have contracted the existing moisture or the capacity of the air for moisture has been vastly increased by the rise in temperature." As a matter of fact neither happened, and, moreover, the air had nothing whatever to do with the matter. The same thing would have occurred if the air had been entirely absent, the aqueous vapor alone present. That is to say, aqueous vapor which at 32° seemed relatively moist, would become apparently drier if heated to 70°, whether the space filled by it were simultaneously occupied by air or not. This independence of the substances was first deduced theoretically by Dalton, afterwards established experimentally by Regnault, at least with a high degree of approximation. Hence it is a change in the condition of the aqueous vapor, not of the air, to which the

apparent drying is due, and it is the nature of this change which I must now endeavor to explain.

I have said that aqueous vapor is always dry. How then can it be at times *apparently* drier than at others? The reason is that we judge of the wetness or dryness of a place by the rate at which evaporation occurs therein. This depends upon the elevation of the temperature of the vapor above its dew-point, or that temperature at which it would condense. Suppose we had a hollow vessel enclosing a perfect vacuum. Now introduce a small amount of aqueous vapor at 32° temperature. The vapor will immediately expand until it fills the whole space, and by the heat vibration of its molecules will exert a certain pressure against the sides of the vessel. If now we introduce some more vapor, the latter will likewise expand and the pressure will be increased. But at 32° the vibrational energy of the molecules is limited. If we keep on adding vapor we shall presently so increase the density that this energy can no longer keep the molecules separate. Some of the vapor will condense. There is then a maximum density or pressure, which, so long as the temperature remains at 32°, can not be exceeded. The vapor is then said to be saturated. Suppose, when we arrive at this point, we raise the temperature to 70°. The heat energy of the molecules is thereby increased, and we shall find that we can now put in considerably more vapor before the limiting density and pressure are reached. Hence the latter rise with the temperature, or, what is the same thing, the dew-point or boiling-point increases with the pressure. Now a moist body must be considered as a source of aqueous vapor. If such a body is put into our saturated vapor at 32° no evaporation from it will take place. If the temperature is raised to 70° the vapor becomes superheated, and more vapor is required to saturate it. The moist body becomes the source of that vapor. Evaporation takes place the more rapidly, the greater the degree of superheat, or in direct proportion as the amount of vapor actually present is in defect of that required for saturation. The ratio of the former to the latter is technically known as the *relative humidity*. Thus the apparent dryness of a place depends solely upon the condition of the aqueous vapor therein, and not at all upon that of the air.

Whenever air is heated for a building it should be moistened; whenever cooled, it should be dried. This is generally appreciated, but unfortunately the arrangements provided are usually inadequate. A very considerable amount of moistening is required. The Sturtevant Company, however, manufactures a heating apparatus in which steam is blown into the hot air current from one of their fans, by means of a nozzle which finely atomizes the steam. This insures good mixing. It is found that with such an apparatus a much lower temperature suffices for comfort, and is also more healthful. In Europe, where the winters are, in general, moister than ours, lower house temperatures are habitual. I spent three winters in Italy, and can vouch for the fact that when the temperature in my study reached 65°, I found it uncomfortably warm. A certain Italian lady, who considered 55° in her own country a comfortable temperature and 60° too warm, finds 70° in this climate insufficient.

The fact that air when cooled increases in dampness is much more noticeable. It is a serious impediment to the use of refrigerating apparatus for cooling houses. Air which at 90° has a relative humidity of only 65 per cent. becomes saturated at 70°. If air thus cooled were admitted to a room, moisture would condense on the walls. Such conditions would naturally be very disagreeable.

Though the above explanations are only a rehash of well-known principles, I hope they may be of some use. In return I wish some one would explain to me just what is the danger of the open window. Why is a little sneaking draught in the house a source of colds and grippe, while a high wind out-of-doors a pleasure and a benefit? This is a problem that has long puzzled me, but perhaps it is a foolish question.

M. MOTT-SMITH

WATERVILLE, ME.

THE MOISTURE IN THE AIR WE BREATHE

Dr. Gulick's letter about the air we breathe in buildings, in the March number of Science, calls attention to some difficulties that have been troublesome to many of us for a long time.

During the winters of 1896–7 and 1897–8, I made a series of observations in office, residential and school buildings in Milwaukee, Wis., giving particular attention to the humidity during the period of artificial heating. The results of this preliminary study were published in a condensed form in U. S. Weather Bureau Bulletin, No. 24, in 1899. Later observation and study tend to confirm most of the conclusions reached at that time, but have failed utterly to furnish a satisfactory answer to that most important and all-including question, why in-door living is less healthy than out-door living. Certainly, there is some condition of environment, inimical to health, seemingly brought about by artificial heating that, thus far, has escaped observation.

The most obvious difference between inside and outside air appears to be in the moisture content, and, as Dr. Gulick asks a number of pointed questions about this important constituent of the atmosphere, a non-technical statement of the generally accepted view may be of interest.

Unfortunately the terminology used to express various conditions of atmospheric moisture was invented before we knew as much as we now think we know about the several factors involved, and, therefore, instead of assisting to a proper understanding tend to confusion.

1. The expression, capacity of air for moisture, is misleading. A better expression is, capacity of space or vapor for moisture, because the presence of air in space has nothing whatever to do with the capacity of the space for moisture, the only effect of the presence of air being to retard the diffusion of moisture within the space.

2. Likewise, the expression, saturation of air, implies that the presence of air affects the amount of moisture required to saturate a given space, which is not the case. It is a rather curious fact that, although atmospheric air is a mixture of nine or ten different gases, each gas, including vapor of water, tends to arrange itself according to its density and acts in all respects as it would if no other gas was present. In other words, each gas forms an atmosphere about the earth independent of all other gases. We, therefore, may eliminate dry air from consideration because it is not a factor in the problem.

To assist in obtaining a definite view let us imagine a cylinder of space 50 feet in diameter extending upward from the surface of a lake a distance of 10 miles, which is about as high as vapor will rise to an appreciable extent in our atmosphere. We will assume that the average temperature of the space within the cylinder is 40° F., and that the temperature of the surface of the lake is the same. How does the water in the form of vapor pass from the lake into this space? The molecular theory of matter teaches that the molecules of water are in a constant state of agitation; that the velocity and amplitude of their vibrations varies with the temperature, being greater for high temperatures than for low temperatures; and that some of the molecules in darting about attain a velocity and direction that carry them beyond the attraction they have for each other, and, hence, they fly off into the space above the water. This is our understanding of the process of evaporation. But it so happens that these molecules of water in the form of vapor do not escape the control of gravity, which operates to pull them down toward the earth in accordance with their weight or density. As the molecules continue to escape and a greater number pass into the space, they impinge more and more upon the surface of the water and increasingly impede the escape of other molecules from the surface, so that the process of evaporation becomes slower and slower. It, however, does not cease entirely, because the molecules of vapor also are in a constant state of agitation, and, in darting about and beat-

ing upon each other, some are carried into the water by their own velocity and some are thrown into the water by the force of the blows received from other molecules, thus decreasing the number in the vapor and allowing others to escape from the water. When the number that escape and the number that are carried and thrown back into the water equal each other a condition of equilibrium is established and the space is said to be saturated.

If the temperature of the space or the vapor within the space now be raised, what will happen?

The molecules of vapor at a temperature of 40° F. have a given velocity and amplitude of motion. The increase of the temperature from 40° to 50° increases their velocity and movement, and to exercise this increased activity requires more space. We, therefore, are accustomed to say that the vapor expands or increases in volume when its temperature is raised. In expanding some of the vapor overflows the original space, and the number of molecules within the space is thus decreased by the number that has been crowded out of the cylinder. This destroys the condition of equilibrium and permits the molecules at the surface of the water to escape again in greater numbers. Thus, the process of evaporation continues, establishing finally as before a condition of equilibrium at the new temperature of 50° F. This is our understanding, why increased temperature gives increased capacity when the vapor is free to expand, except for the control of gravity. But if we put a lid on the cylinder and thus confine the vapor to a definite space we limit the field of its activity but not the activity itself. The effort of vapor, humidity, steam, water gas—whatever name we may use to designate it—to obtain more space increases with its temperature whether confined within a limited space or not. If the space is limited the effect is increased pressure; if not limited increased volume. In either case it obeys the laws of gases. The only difference between atmospheric moisture and steam is that the activities of the former are limited by gravity alone, while the activities of the latter are confined to a definite space.

WILFORD M. WILSON
CORNELL UNIVERSITY

A VARIANT IN THE PERIODICAL CICADA

WHILE collecting material for a study of the mode of pigment formation in the periodical cicada (*Tibicen septendecim* L.) my attention was attracted by an adult male in whose eyes the red pigment was lacking. The specimen was secured at Summit, N. J., on June 6, and although the cicadas occurred there in countless thousands I searched in vain for a second specimen.

The example secured differed from the usual form not only in lacking the red pigment of the eyes, which in this specimen are perfectly white, but also in the coloration of the wing veins. In this individual the costa of the fore wings and the costa and the greater portion of the radius and media of the hind wings lack the typical orange coloration and are perfectly colorless.

Morgan[1] has recently caused white-eyed mutants to occur in *Drosophilia* by closely inbreeding and it may be that this specimen originated in the same manner if we assume that the entire colony is descended from one pair of cicadas. A study of the inheritance of this trait would be very interesting, but such a study is obviously impracticable owing to the long period of adolescence.

ROSS AIKEN GORTNER
STATION FOR EXPERIMENTAL EVOLUTION

[1] Morgan, SCIENCE, N. S., XXXIII., No. 849, p. 534, April 7, 1911.

QUOTATIONS

TRIPPED BY RED TAPE

THAT the Department of Agriculture should be in danger of losing three of its leading experts on food adulteration, Wiley, Bigelow and Rusby, on account of a technical violation of the salary regulations, shows how a government is hampered by its bureaucratic methods. It is not claimed that Professor Rusby, of Columbia University, was avaricious in refusing to work for $9 a day or that the departmental authorities who arranged for him to be paid at the rate of

$20 for part of the year were wasting public funds. Any one of these three men, if he had been willing to put his knowledge of chemistry at the service of an adulterator of food or an evader of customs, could have made a great deal more money and had a much easier time of it.

It is not merely a pecuniary sacrifice which must be made by men of exceptional ability and proficiency when they enter any branch of government employ. A greater deterrent is the fact that they find that they are not free to work in their own way but have to submit to the detailed dictation of a lot of clerks and lawyers. This is particularly the case with the scientific departments. The scientific temperament is in eternal conflict with the legal temperament. The one cares only for results; the other insists upon methods. The former is striving for something new; the later sticks to precedents. Consequently the scientific men in government employ are apt to be in a chronic state of irritation unless they are of the conventional routine type of mind, that is to say the unscientific type of mind. In the case of a high spirited and original genius this irritation sometimes rises finally to the pitch of exasperation and he goes off on a tangent, sending in a farewell letter to "the department" telling them just what he thinks of them for refusing to pay for that tin cup which he bought without the proper requisition or for sending back his last report because only one color of ink was used on it. Men of calmer temper will get along somehow rather than give up work they are interested in, paying for the things that are necessary but not allowed, out of their own pockets, or collecting money on the side from some patron of science, and resorting to various evasions and misclassifications to get within the letter of the law. Probably the strict and literal enforcement of all the regulations in any department would stop its work. We have experimental evidence in support of this supposition, for in France and Italy it has been tried in the government railroad and postal service, where the employees instead of striking decided to obey the rules, all of the rules, all of the time. The result proved that obedience was better than sacrifice of wages because it was more effective in tying up the traffic.

The United States government has been remarkably liberal in its appropriations for scientific purposes, both theoretical and practical, but the results have not always been commensurate with the expenditure, partly because of the conditions under which the work had to be performed. By a process of natural selection the men of greatest initiative and originality tend to be eliminated out of the system. This is why the phrase "Washington science" is so commonly used in a derogatory sense.

Now the Bureau of Chemistry, under Harvey W. Wiley, for the past twenty-eight years has succeeded in keeping out of the ruts. It has set a fast pace for the state agricultural experiment stations. It has made many original contributions to science. It has initiated many valuable reforms in legislation and in agricultural practise. Dr. Wiley has a good temper. He laughs and grows fat on worries and opposition that would drive some men mad. He has been able to live in a bureaucratic atmosphere without losing his scientific spirit, or, what is more remarkable, his zeal for reform.—The *Independent*.

DOCTOR WILEY

(With apologies to Rudyard Kipling)

''What makes the Potted Ham so green?'' said Files-on-Parade.
''It's feelin' fresher than it is,'' the Color Sergeant said.
''What makes the ranks so white, so white?'' said Files-on-Parade.
''They're dreadin' what they've got to eat,'' the Color Sergeant said.
''For, they're bouncin' Doctor Wiley, you can hear the Microbes cheer,
And the Germs is all a-singin' 'Wiley's goin' away from here,
And we're comin' back far stronger than we've been for many a year,
For they're bouncin' Doctor Wiley in the mornin'.' ''

. . . .

"'For what do they be bouncin' him?'' said Files-on-Parade.
"'E put the Microbes on the blink,'' the Color Sergeant said.
"An' did the Microbes 'urt the Blink?'' said Files-on-Parade.
"They put the Blink out of a job,'' the Color Sergeant said.
"They are bouncin' Doctor Wiley, and the germs are runnin' free,
And the Microbes an' Bacilluses are chortilin' with glee,
For they'll get their starvin' 'ooks once more on folks like you an' me,
After bouncin' Doctor Wiley in the mornin'.''

—Horace Dodd Gastit, in *Harper's Weekly*.

SCIENTIFIC BOOKS

Handbuch der Klimatologie. Von Dr. JULIUS HANN, Professor an der Universität Wien. Dritte Auflage. 3 Volumes. Prices 15; 15; 23 Marks. Stuttgart, J. Engelhorns Nachf. 1908, 1910, 1911.

A laborious work is now completed and published. The progress of science may years hence suggest modifications and improvements. The history of science may bring into prominence the names of others than those quoted in this great work, but for the present this monument must stand alone, towering over other books as the pyramids of Gizeh tower over the valley of the Nile.

For forty years past Dr. Julius Hann has been filling meteorological journals and literature with a steady stream of works on the subject that has absorbed his thoughts and life. Neither Newton nor Laplace surpassed him in intense concentration of effort; neither Euler nor Humboldt have published more voluminously. Neither "The Voyage of the *Challenger*" nor all the polar expeditions of the past thirty years have contributed more to our accurate knowledge of the atmosphere of our own globe.

In three volumes of text totalling 1,400 octavo pages "The Founder of Modern Climatology" has given us both numerical and textual descriptions and comparisons covering all the characteristic features, both the general and the special local characteristics, of all the known climates of the globe. At first sight it would seem impossible to do this; but at numerous localities the forces that build up local climates are the same, so that the relative importance of one or the other force controls the result.

Complex as are the atmosphere and its relations to the earth and man, to geology and biology, to history and religion, yet all can be analyzed into temperature, moisture, sunshine and wind. The tabulation of these fundamental data gave Hann the handy material for statistical intercomparison and study. Hence his volumes are crowded with facts—dry facts, if you will, but reliable material for careful study. Of course the popular writer, the superficial traveler, the advertising land owner, is satisfied with a few striking items; but the careful engineer, the large planter, the discriminating physician, need every possible detail that can affect any feature of human interest. It is for these and all other accurate students that Hann has compiled these solid volumes. The exhaustive range of his reading, the continuous appeal to the pencil memoranda that he must have kept, the quotations of reliable figures instead of general verbal descriptions, make one feel that here we have condensed facts and not fancies. Even the elusive "sensible temperature" or "curve of comfort" or the sensation of temperature seems reducible to an exact function of temperature, humidity and wind.

Of course no satisfactory résumé of Hann's "Climatology" can be given here. We need only say that volume I. (Stuttgart, 1908) is the revised edition of an earlier work, translated and published in 1903 by Professor R. DeC. Ward, of Harvard University.

The second volume (Stuttgart, 1910) deals with the tropical zone or the whole region between the tropics of Cancer and Capricorn. This is one half of the whole globe and in some respects the most important half; it extends from New Orleans, Cairo, Bagdad, Hong Kong, Hawaii, and the Bonin Islands on the north, to Peru, Bolivia, Paraguay,

Madagascar, Java on the south. Therefore it includes the Amazon, Nile and Niger, Zambesi and the rivers of India. The third volume treats of the north and south temperate zones and finally, also, the Arctic and Antarctic regions. The latter are small in area but exceedingly interesting in their mysteries. The temperate zones are those on which we love to dwell because there the events of the modern world have taken place. Of course the six hundred pages of Hann's third volume, devoted to the temperate zones, and the following one hundred, devoted to the Arctic and Antarctic regions, are full of interest and novelty. Although we think our annual means of temperature are moderate and temperate as compared with those of the polar regions and the tropic zones, yet the monthly means and the annual ranges show the greatest contrasts. Thus we may have $-40°$ C. and $-50°$ C. as the normal for an average January in northeastern Asia, while the same Januaries in southern Asia, in Japan and China, Afghanistan, Persia, may be from zero up to $+10°$. By analogy we find the January temperatures in North America show similar contrasts, such as $-14°$ C. at Bismarck, N. Dak., and $+12°$ C. at New Orleans; or $10°$ C. at San Francisco and $-5.6°$ C. at Portland, Me. Such contrasts of average temperature give zest to life in the temperate zones.

CLEVELAND ABBE

Resultats du voyage du S. Y. Belgica en 1897, 1898, 1899, sous le commandement de A. de Gerlache de Gomery: Océanographie, les glaces, glace de mer, et banquises par HENRYK ARCTOWSKI; Schizopoda and Cumacea by H. J. HANSEN, 1908; Diatomées par H. VAN HEURCK; Petrographische untersuchung der Gesteinsproben von A. PELIKAN; and Quelques Plantes fossiles des terres Magellaniques par A GILKINET. 1909.

Still another batch of publications on the results of the *Belgica* expedition to the Antarctic is at hand, and more to come, according to the schedule, though one can not help wondering if volume X., by Dr. F. A. Cook, will eventually be among them, as originally announced. In the present instance the work is by scientists of quite another stamp.

In his discussion of the different forms under which ice appears in those regions Arctowski attempts to systematize and sum up the data given much more fully in his journal of the voyage; and also to consider the question of the limits of the ice pack, historically and from the *Belgica* observations. The movements and behavior of the pack and floe ice are fully explained. The character of the surface and how it is affected by wind and snowstorms are admirably shown by excellent half-tone reproductions of photographs.

Hansen devotes 20 pages and three excellent plates to the study of the crustacean Euphausia, Cyclaspis and related forms of marine habitat, so characteristic of the austral seas.

Van Heurck treats of the diatoms obtained in samples of the bottom obtained in sounding and in the residue from melted sea ice obtained at various places. The diatoms of the plankton are reserved for further study. An appendix on the diatoms of Kerguelen and a complete list of polar diatoms, Arctic and Antarctic, complete the memoir which is illustrated by thirteen phototype plates whose execution leaves nothing to be desired.

The photography of the rock specimens brought home by the expedition is the subject of Pelikan's memoir. The rocks are crystalline or igneous, mostly granite, diorites, porphyrites, basalts and gangue minerals. Two plates of magnified microscopic sections accompany the text.

Gilkinet devotes a few pages to a few fossil plants, mostly beeches and *Myrtiphyllum*, not new, but which present a certain interest because they come from a station near Punta Arenas, not far from a locality visited by the Swedish expedition, and comprise species not hitherto known from that locality, but only from the Sierra de los Baguales at a considerable distance from the *Belgica* locality. Also the maps showing geological distribution have not indicated hitherto tertiary beds at

the *Belgica* locality which is Passo del Cabeza del Mar, near Pecket Harbor, Strait of Magellan.

The members of the *Belgica* expedition are to be congratulated on the quantity as well as the quality of the results of their arduous labors in the field.

WM. H. DALL

The Subantarctic Islands of New Zealand. Reports on the geophysics, geology, zoology and botany of the islands lying to the south of New Zealand. Philosophical Inst. of Canterbury, Wellington, N. Z. Government printer. 1909. 848 pp., 4to, plates, text-figures and maps.

New Zealand is situated upon a submarine bank, roughly twenty degrees of longitude wide and twenty-five degrees of latitude long in a north-and-south direction within the 1,500-fathom curve. The islands of which this report treats, with the exception of the Macquarie group, are included within the 1,000-fathom curve together with the north and south islands of New Zealand proper. The most important groups are those of the Chatham, Bounty, Antipodes, Campbell and Auckland Islands. Only Macquarie and Campbell are within the northern limit of drifting ice, but the curve-enclosing sea bottom less than 2,000 fathoms in depth indicates a connection between the neozelandic bank, the Antarctic lands and Australia by way of Tasmania.

The climate of these islands is cold, wet and tempestuous, their coasts in large part inhospitable, with projecting reefs and dangers; and the record of shipwrecks and loss of life, or extreme privation of survivors, is most melancholy. Into these perilous waters the search for the fur seal and sea elephant drew many adventurers, a goodly number of whom hailed from the United States; and, while occasional fortunes were made, many ships and men suffered disaster.

The government of New Zealand has established depots of provisions and other necessaries on the principal islands, for the relief of shipwrecked mariners, and once a year the government vessel makes the round of the islands to supply or repair these depots and rescue any persons who may have reached these desolate shores. On the petition of the scientific societies of New Zealand, the authorities agreed to transport an exploring party to Auckland and Campbell Islands and to pick them up on the return trip in 1907.

The collections and observations thus made form the basis of two handsome volumes, consecutively paged, profusely illustrated, and edited by Professor Charles Chilton, of the University of New Zealand.[1] The government of New Zealand contributed a substantial sum toward the expenses of publication.

The fauna and flora of these isolated islands, seldom visited by man and into which only a few pests like rats and mice from whaling ships or sealers can have been unintentionally introduced, have a very special interest, not only on account of the modification the plants and animals have undergone, but for the light they may throw on the former distribution of Antarctic lands.

It is impossible within the space assigned to us, to discuss the several papers by specialists which are brought together in these volumes, but a brief list of the subjects treated will indicate their contents.

Following an account of the expedition and an historical survey of the islands we have articles on magnetics; on the radium content of certain igneous rocks; on the meteorology and geology of Campbell Island; on the physiography, geology, soil and soil formers of the various islands; on the vertebrates, mollusca and general entomology; special articles on macrolepidoptera, lepidoptera, hymenoptera, coleoptera, diptera, collembola, spiders, crustacea, polychæta, oligochæta, echinoderms, holothurians, planarians, nemerteans, leeches, myriapods, medusæ, actinians, sponges and foraminifera. In botany articles are provided on systematic and ecologic botany, plant formations and associations, grasses, algæ and cryptogams. A summary of the biological relations of the islands, by the editor, a bibli-

[1] The volumes may be had of Dulau & Co., 87 Soho Square, London, the agents of the Philosophical Institute of Canterbury, New Zealand.

ography, an excellent index and a general map of the Antarctic and sub-Antarctic regions concludes the work.

Much of the land mass of the islands is of igneous or granitic rocks, but fossils of tertiary age, in limestone, have been found on Campbell Island and all the conditions indicate the probability that all the islands formed part of a continental area connecting them with New Zealand. Wingless species or species with reduced wings are numerous among the insects, as might be expected.

In his general review the editor leans toward the theory of a great Antarctic continent in the warmer Tertiary time—with connections or close relations with Patagonia, South Africa and Australasia—as best explaining the distribution of animal and plant life now existing and the fossil remains which have been collected in the Antarctic and sub-Antarctic regions.

Wm. H. Dall

ANNUAL INTERNATIONAL TABLES OF PHYSICAL AND CHEMICAL CONSTANTS

At the International Congress of Applied Chemistry, held in London in 1909, an international commission was appointed with power to undertake the publication of "Annual Tables" containing all constants and other numerical data which may be of interest in physics, chemistry or in the technical applications of these sciences. The plans outlined by the commission received the endorsement of the International Association of Academies and the official recognition and financial support of many of the governments and learned academies of the world. Since its inception the commission has been enlarged and made more thoroughly representative of the various branches of science. It is now composed of twenty-five chemists and physicists representing the following countries: Austria, Belgium, Great Britain, France, Germany, Holland, Italy, Russia, Scandinavia, Spain, Switzerland and the United States.

Owing to the immense volume of scientific and technical literature which is continually being produced, the difficulties in the way of ascertaining whether any given measurement has been made or not are increasing year by year. Existing systems of indexing and abstracting offer only limited help, since a large number of measurements are made in the course of researches to which they are purely subsidiary, so that their existence can not be inferred from the titles and subtitles of the papers in which they are recorded. Also, tables which appear only at long intervals, such as those of Landolt and Börnstein, can of necessity cover only a small part of the ground and are never quite up to date. The "Annual Tables" should therefore fill a serious gap which has hitherto existed in the systematic indexing of scientific and technical results.

During the year 1910 all scientific publications which might contain material of value were systematically scrutinized by a large corps of abstractors. From the data thus obtained a volume of tables and bibliography is about to be published, covering the year 1910. The volume will form a valuable addition to the physical chemical tables which already exist and will, together with the succeeding annual volumes, prove a powerful aid to the work of the investigator, both in pure and applied science, and will enable him to find with ease those data which he may require and which it would be most difficult to obtain by individual search. Many important constants published in little used journals, or in papers which are inadequately indexed, will be saved from oblivion. Each value, given in the tables, will be accompanied by the name of the author, by a reference to the original paper and by an indication of the exact conditions under which the measurements were made. The text of the tables will be printed in English, German, French and Italian.

The committee urgently requests authors of scientific papers to cooperate with them by sending to one of their number (two) reprints of all articles published. This is especially desirable in the case of papers published in the form of theses, of government

reports, or in any journal which might not come to the attention of the abstractors.

It is expected that the publication of the tables will, after three or four years, become self-supporting. In the meantime, generous subscriptions have been made by governments, academies, scientific societies and individuals throughout the world; but further subscriptions must be obtained before the continued success of the project is assured. The general secretary, Dr. Charles Marie, 98 Rue du Cherche-Midi, Paris, and the members of the International Commission serve without remuneration.

Information concerning the "Annual Tables" or the work of the international committee will be gladly furnished by the undersigned American members of the committee.

G. N. Lewis,
Massachusetts Institute of Technology, Boston, Mass.
G. F. Hull,
Dartmouth College, Hanover, N. H.
J. Stieglitz,
The University of Chicago, Chicago, Ill.

SPECIAL ARTICLES

CHEMISTRY OF THE SILVER VOLTAMETER[1]

Among the questions relating to the chemistry of the silver voltameter which have been investigated more or less in detail are the following: (1) Effect upon electrolyte of the various septa employed in the different types of voltameters to separate the anode electrolyte from that of the cathode; these septa include (*a*) filter paper, (*b*) silk, and (*c*) porous pots of unglazed porcelain; (2) the effect of various kinds of impurities upon the weight of the silver deposit and the explanation of this effect; (3) the preparation and testing of pure silver nitrate free from traces of impurities which produce disturbing effects in the voltameter; (4) anode secondary reactions; (5) cathode secondary reactions; (6) preparation of the silver anode; (7) purity of the silver deposit.

Of these, the first question has been studied in greatest detail, principally because of the fact that it includes the cardinal differences between the various types in use by national standardizing laboratories. It early became evident that the different results obtained with the various types was due principally to the effect produced by these septa, and that two of them introduced errors of much greater magnitude than any ordinary variations in the conditions or in the purity of different samples of even commercially pure silver nitrate. However desirable it might have been to have devoted every energy to the preparation of pure electrolyte and to its protection from contamination during the experiments, it was nevertheless necessary first to show, *if possible,* just what the nature of the action of the septa might be, since the primary object of the work was a *study of the silver voltameter as actually used,* and especially as used by the various standardizing laboratories, with a view of determining a uniform type if possible. The results of the investigation of the effect of filter paper seem to show that ordinary filter paper is superficially covered with oxycellulose, which can be extracted with water but which again forms spontaneously when the filter paper is allowed to remain in contact with the air. This oxidation is probably due to fermentation. This oxycellulose solution (colloidal) very readily reduces silver nitrate solution to colloidal metallic silver, which is very similar in properties to the colloidal silver of Carey Lea. Permanent colloidal solutions of silver have been prepared from concentrated aqueous extracts of filter paper. This reduction of silver nitrate is probably due to the intermediate formation of *furfuraldehyde* since the oxycellulose solution is readily decomposed into this aldehyde by the action of exceedingly dilute nitric acid of no greater concentration than that which is probably present in neutral silver nitrate solution (due to slight hydrolysis). Furfuraldehyde, especially the polymerized variety, produces all the *peculiar* effects which have been observed with filter paper, *e. g.,* imparts to the electro-

[1] Read before the Philosophical Society of Washington, May 20, 1911.

deposited silver a strongly striated and non-crystalline appearance. Other *strong* reducing agents produce similar effects, but to a less extent. Cane sugar and starch do not produce these effects.

It is very probable that the final effect of the filter paper in increasing the weight of the silver deposit is principally due to the deposition of the *colloidal* silver (by cataphoresis) and also some of the protective or "schutz" colloid-oxycellulose upon the cathode along with the electrolytically deposited silver, resulting in a breaking up of the usual crystalline form of the silver so that it occludes greater amounts of electrolyte. Thus, an unweighable amount of colloid can increase the weight of the silver deposit by a quite appreciable amount. Of course, the weight is further increased by the actual mass of the colloid deposited, but this seems to be a small per cent. of the total increase.

Silk when first used produces an effect very similar to that of filter paper, due to the ease with which it is partially decomposed into aldehydes. After repeated use in the voltameter, this aldehyde decomposition ceases, and it renders the electrolyte strongly acid, probably due to its decomposition into amino-acids. Since, in general, the effect of acid is to decrease the weight of the silver deposit, this fact probably accounts for the progressively decreasing values obtained with a voltameter with silk septa as compared to those obtained with the porous pot type.

Porous pots, when prepared according to certain specifications, have practically no effect upon the electrolyte so far as could be determined. If not so prepared, they render the electrolyte slightly acid and very faintly reducing in character. This *very slight* action is probably catalytic in character, and probably consists in a slight reduction of the silver nitrate to colloidal silver with the formation of an equivalent amount of nitric acid. This action lies at the basis of electrostenolysis. Of all the septa, the porous pot is by far the most inert.

In addition to colloidal silver, certain other colloids produce similar effects, as colloidal silica and colloidal silver hydroxide, whereas other colloids like hydrocarbons and starch do not. It is evidently a matter of whether the colloid migrates to anode or cathode *under the conditions* which *obtain in the voltameter*. This direction of migration may of course be different under other conditions.

Next to the presence or absence of strongly reducing impurities or certain colloids, the condition of *neutrality* of the electrolyte has the greatest effect upon the results. A method has been developed for defining the neutrality to within a part in a million of nitric acid. Fused silver nitrate when prepared according to the methods described in the literature is both slightly basic and also contains minute traces of reducing impurities which are very objectionable in voltameter work. Recrystallized silver nitrate (from neutral solution) is slightly basic, consequently the recrystallization must be made from acid solutions. This acid may be removed by recrystallization or by careful fusion, but the neutrality must be tested in either case.

There is no evidence of any secondary reactions at the cathode. The anode solution remains practically neutral, but if appreciably acid at the start tends to become neutral. The same is true when no septum is used. This indicates a secondary reaction of some sort at the anode. No evidence was found of the formation of reducing substances at the anode, such as a sub-silver nitrate. The evidence obtained by other investigators of the formation of such substances seems to be at least partially vitiated by the fact that in some cases at least the anode solution was filtered through filter paper. In other cases, the character of the filter is not mentioned.

No considerable work has as yet been done on the last question (7).

In the future work, the electrolyte will be subjected to ultramicroscopic examination for the presence of colloids.

A. S. McDaniel

Bureau of Standards,
Washington, D. C.

SCIENCE

FRIDAY, AUGUST 11, 1911

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE CHEMISTRY OF ANESTHETICS[1]

IDIOSYNCRASY has in the past accounted for—serves now to account for—unusual observations in the use of drugs, and perhaps will continue to cover much of our lack of information as to their real therapeutic action, but I am of the opinion that it is a "magic skin."

Sacred, profane and mythological literature abound in incident, fact and fancy, showing that from earliest times man has sought to assuage grief and pain by some means of dulling consciousness. Recourse was had to the inhalation of fumes from various substances, weird incantations, application of drugs, both external and internal, pressure upon important nerves and blood vessels, and the laying on of hands, or animal magnetism. Each has played its part in the mitigation of human ills. It was not until the close of the eighteenth century, however, that modern surgical anesthesia was foreshadowed. Then it was that the discovery of hydrogen, nitrogen, oxygen and nitrous oxide—pneumatic chemistry, as it were—created a field of pneumatic medicine. In 1789, the Pneumatic Institute was founded for the purpose of investigating the "medical powers of factitious airs or gases" and was set up at Clifton by Dr. Beddoes. The immediate idea to be followed out was the treatment of phthisis and other lung troubles by inhalation of various gases. Humphry Davy was assigned the office of superintending the experiments. Davy actually inhaled nitrous oxide, and re-

[1] A lecture delivered at the general meeting of the American Chemical Society, Indianapolis, June 28, 1911.

corded his own sensations and the behavior of others after they had inhaled it.

In 1805, Dr. Warren, of Boston, used "sulphuric ether" on a patient suffering with phthisis, and the year following it was used in attacks of asthma; but Faraday, in 1818, was the first to recognize its value as an anesthetic.

Chloroform was discovered in 1831 independently by Liebig, Soubeiran and Guthrie. It is reported in the *American Journal of Science* for January, 1832, that Dr. Ives, of New Haven, used chloroform in surgery.

In 1828, Girardin read a paper describing surgical anesthesia by means of inhaled gases, but the honor of the discovery of surgical anesthesia has been claimed with more or less acrimonious partizanship for four others, namely, Long, of Jefferson, Ga., who anesthetized a patient with ether in 1841; Wells, of Hartford, Conn., who used nitrous oxide in dentistry in 1844; Morton, a pupil of Wells, used ether instead at the suggestion of Jackson, a chemist, who later claimed to be the real discoverer. Simpson, in 1847, first used ether in midwifery and later chloroform, whose anesthetic properties had been previously described by Flourens. In 1868, Andrews, of Chicago, called attention to the use of oxygen with nitrous oxide to produce a non-asphyxial form of anesthesia. In 1906, Brown, of Cleveland, used a warmed mixture of nitrous oxide and oxygen, followed by ether and chloroform, with great success; and in 1909 Gwathmey, of New York, first used warm moist vapors of pulmonary anesthetics.

I shall not recount the historical data which have to do with other anesthetics, a list of which I have published in the *American Druggist*, as my remarks this morning will be limited to nitrous oxide, ether and chloroform, and these few facts—the results obtained from careful unbiased investigation of the literature and other forms of evidence—are given without elaboration or argument.

The speaker knows of no satisfactory basis of classification of anesthetics, hence those that are to be considered will be taken up in chronological order.

NITROUS OXIDE

In 1772 Priestley first prepared nitrous oxide by reducing NO with moist iron filings. In 1793 Deiman and others prepared the gas by heating NH_4NO_3, essentially the commercial process for its manufacture to-day. It is usually carried out by heating mixed salts, as $NaNO_3$ and $(NH_4)_2SO_4$, $NaNO_3$ and NH_4Cl, etc.[2]

Commercial nitrous oxide is apt to contain these impurities: Cl_2, NO, NO_2, HNO_3, NH_3, HCl, CO_2, O_2, N_2 and rare gases of the air. It is usually purified by passing through solutions of sodium hydroxide, ferrous sulphate and sulphuric acid. Further purification may be accomplished by the formation of a hydrate[3] (N_2O, $6H_2O$) below 0° C. and heating this hydrate, with fractional condensation[4] and subsequent fractional distillation.

Beyond the absence of disturbing impurities, the improved methods of the use of nitrous oxide for anesthetic purposes demand a knowledge of the approximate content of nitrous oxide in the commercial product, as will become apparent later, hence a method for its determination is desirable. Various methods have been proposed, for instance, decomposition into N_2 and O_2, burning with hydrogen, explosion with hydrogen, combustion of

[2] The subject is thoroughly covered in a paper by the speaker and Stevenson, *J. Ind. and Eng. Chem.*, **3**, No. 8.

[3] Villard, *Compt. rend.*, 1894, **118**, 1096.

[4] Stolzenberg, *Ber.*, **43**, 1708.

charcoal with absorption of CO_2 produced, explosion with CO, oxidation of fused mixture of sodium carbonate and Cr_2O_3 and determining the amount of Na_2CrO_4 produced, and absorption in absolute alcohol; and none is satisfactory. There is no good test for N_2O known to me. Dr. Stevenson and the author devised a new method, which gives accurate results in hands skilled in the manipulation of gases. It depends upon passing a definite quantity of the gas over heated copper gauze, after a preliminary treatment to remove oxygen, or compounds which produce copper oxide, from the sample, and then passing hydrogen through the apparatus, absorbing the water formed.

The following table, which is self-explanatory, exhibits the results of our analyses of compressed nitrous oxide as supplied by American manufacturers:

No.	Analysis								
	N_2O	H_2O	CO_2	NH_3	O_2	N_2, etc., by diff.	N_2O by explosion	N_2O by $Cu+CO_2+H_2$	N_2O by $Cu+H_2$
1	99.7	0.13	0	0.006	present	0.16	97.5	99.4	99.7
2	96.6	0.15	0	0.001	present	3.25	95.0	96.2	96.6
3	99.5	0.15	0	0	present	0.35	97.3	99.5	99.5
4	95.9	0.16	present	0	present	3.94	94.1	95.6	95.9

Nitrous oxide which is to be used for anesthesia should contain at least 95 per cent. of N_2O and no solids, liquids, combustible organic matter, chlorine or other oxides of nitrogen. A small amount of carbon dioxide, according to the investigations of Gatch, can have no evil effects. If present, however, the per cent. should be known.

ETHYL ETHER

Experience of expert anesthetists, not accounted for by idiosyncrasy, obtained in the use of ethyl ethers supplied by various manufacturers in numerous surgical cases, furnished one of the motives for my investigations into the chemistry of anesthetics. The standards laid down by the various pharmacopœias of the world are not uniform. In view of that fact alone, a thorough investigation seemed called for. Enquiries addressed to large consumers of the solvent in manufacturing processes adduced further need for satisfactory methods of determining the purity of ethyl ether and of detecting impurities introduced, or proving their absence if eliminated, in the modification of raw products used in its manufacture. The presence of small amounts of substances has oftentimes been the cause of a chemical reaction proceeding in a particular direction by virtue of a so-called "catalytic" or other unknown action. So the presence of even traces of certain substances, as peroxidized compounds, aldehyde, etc., may have caused some reactions to be incorrectly explained, or to follow an unusual, or unaccounted for, route.

Ethyl ether is still made commercially by the historical process of treating alcohol with sulphuric acid, hence the misnomer of "sulphuric ether." Although a number of synthetic processes have been proposed, some of which have been tried out, none has proved a commercial success.[5]

[5] In this connection, reference may be made to the method devised by Fritsche for the preparation of ether free from alcohol. In this method, gas containing ethylene is treated with sulphuric acid (*Z. anal. Chem.*, **36**, 298; U. S. Patent No. 475,640, January 19, 1897), and the ethyl-sulphuric acid so obtained is converted into ether and sulphuric acid by means of water. This process was operated on a commercial scale in this country for some time, but it was reported that the industry was destroyed by the Denatured Alcohol Act (Bull. 92, U. S. Dept. of Commerce and Labor, Bureau of the Census, **1909**, p. 96). It is likely, however, that a similar industry may be revived, as natural gas might serve as a suitable material from which to prepare ether (cf.

The *quality* of ethers on the market depend upon, first, the purity or grade of the alcohol used; and second, secondary reactions which take place not only with impurities in the alcohol, but with ethyl alcohol itself. For example, ethyl ether made from ethyl alcohol denatured with methyl alcohol contained other ethers, as dimethyl oxide or methyl-ethyl ether, not found in the ether made from the old rectified spirit. The liberal interpretation of the Denatured Alcohol Act by our government officials, whereby alcohol denatured by ether itself may now be used, eliminated these substances. Many of the impurities traceable not only to the quality of the raw products used, but the secondary reactions due to their virgin impurities, as variations in temperature, pressure, and other conditions, were removable, and have, in a large measure, been removed or much reduced, by subsequent purification.

The specific gravity of ether intended for anesthesia should not exceed 0.720 at 15° C., providing an ether containing minimum quantities of alcohol and moisture is required; however, an ether which shows a specific gravity of 0.7215 (2 per cent. absolute alcohol), 0.7228 (3 per cent. absolute alcohol), or even 0.724 (4 per cent. absolute alcohol), providing the sole "impurity" is ethyl alcohol, is acceptable for anesthetic purposes according to various pharmacopœias.

In this connection it may be stated that for various reasons a pure ether may be diluted with ethyl alcohol when it is to be used for anesthesia. Impurities then observed may be due in part to the alcohol used in dilution. Practically all ethyl alcohol contains some acetaldehyde.

Ethyl alcohol serves, it is asserted, as a preservative for ether when the latter is properly stored; and small amounts interfere in no way with the application of ether in anesthesia. However, the presence of alcohol is unnecessary except when ether is administered by the "drop method." In this case, the presence of alcohol prevents too rapid volatilization and consequent chilling of the apparatus with which the ether is administered. Some have maintained that pure ethyl ether is unsuitable for anesthesia, but it is a fact that the vapor from ether containing alcohol, when passed through water at 40° C., whereby the alcohol is removed, may be and is being used with great success for anesthesia. The presence of excess moisture should be guarded against in the storage of ether, since ether in contact with water or moist air gives rise to various impurities of an objectionable nature. Thus anesthetic ether of proper grade when prepared may develop impurities to be avoided quite as much as if they had been introduced in the original materials or later produced in the manufacture or added in the preparation for distribution in commerce.

Instances of sophistication have been known, but now they are comparatively rare.

Dr. Davis, of the Johns Hopkins Hospital, has made observations on the temperatures of a number of patients anesthetized with ethyl ether by the "drop method" and by warm vapors of ether. In the former the body temperature dropped 1 to 2° F., and in the latter not more than 0.3° F. in any case.

Ether, when freshly distilled over sodium, possesses a specific gravity of 0.7178 to 0.719 at 15°/4° C.; but if it is not, immediately after its rectification, drawn off into vessels, which are at once sealed and carefully stored, the specific

French Patent 352,687, of 1905, of Lance and Elworthy).

gravity increases in a short time. The purest ether procurable on the market is of 0.718–0.719 specific gravity at 15°, but this absorbs water on exposure to the atmosphere and rises to 0.720–0.721 specific gravity, when it becomes fairly constant.

Since the specific gravity of ether is 0.7178 to 0.719 at 15° C., those requiring ether of 0.720 specific gravity thus allow minimum amounts of water and alcohol. Unless the ether is dried carefully by means of sodium, for example, and is kept constantly dehydrated by storing over such an agent, or great care is taken in storing it after final rectification, it is practically impossible to maintain the specific gravity originally possessed by the ether.

The speaker, assisted by Mr. W. A. Hamor, has conducted an extensive investigation on the changes which occur in ethyl ether during storage, and the experimental data obtained[6] lead to the conclusion that the oxidation of ether in the presence of moisture is productive of a series of complex conversions, initiated, however, by the formation of hydrogen dioxide. The slow combustion of pure ether in the presence of water, and under such conditions as exist when it is improperly stored, would appear to occur in the following stages:

1. The formation of hydrogen dioxide from water and oxygen of the air. This is particularly likely in cases where there is direct exposure to light, and it is more or less activated by contact action.

2. Dissociation of hydrogen dioxide into water and oxygen, which latter then exerts a direct oxidizing action, resulting in the formation of the following: acetic peroxide, acetaldehyde and acetaldehyde peroxide, and eventually acetic acid. The formation of acetic peroxide facilitates a series of oxidations, and by its hydrolysis alone acetic and peracetic acids are formed. The peracetic acid then becomes converted into acetic acid and hydrogen dioxide. Therefore it is reasonable to conclude that a continuous cycle of changes occurs in ether during its oxidation and that such changes result in the simultaneous formation and occurrence of peroxidized compounds, intermediate (aldehyde) and ultimate (acetic acid) resultants.

Our experimental work seems to establish beyond any doubt the fact that ether of anesthetic grade contains peroxidized compounds after exposure to varying temperature conditions and sunlight, in the presence of atmospheric oxygen, for considerable periods of time, especially when it is stored in colorless glass vessels or in badly stoppered tin containers.

Aldehyde is undoubtedly the commonest contaminant of anesthetic ethers, and its presence may account for some of the observations made in practise. It is one of the impurities most likely to be generated by exposing partially filled containers to varying atmospheric conditions for long periods of time. Ether should not be stored in glass vessels for any length of time without being tested for oxidation products before use; and the tin containers should be of such capacity that they need not be opened without being emptied when the ether is employed for anesthetic purposes.

With regard to the acidity of the various anesthetic ethers on the American market, it may be said that none that we have examined contained acids (sulphurous, sulphuric, acetic) in what may be termed injurious amounts, since the amount present never exceeded 0.002 gram of acetic acid per 100 c.c. of the sample in any case. The degree of acidity is liable to vary more or less in both direc-

[6] *J. Ind. and Eng. Chem.*, 3, Nos. 5 and 6.

tions in short intervals during storage in glass vessels, just as in the case of the oxidation of ether itself. The variations in acidity—theoretical, but not sensible in general—may be due to differences between the rapidity of the oxidation and the saturation of the acids by the bases of the glass. In fact, it should be mentioned here that the nature of the ether container is of vast importance in the light of the oxidation changes which are possible. The extent of the oxidation—or, for that matter, any oxidation at all—is dependent upon the quality of the glass used in bottles for storing ether; and in the case of metallic containers, in view of some recent researches, it is probable that all metals which show anomalous anodic conductivity are likely to develop free hydrogen dioxide in contact with water and oxygen. The presence of such metals should, therefore, be guarded against.

Since it is highly important that ether intended for anesthetic purposes should be carefully manufactured and properly stored, as prolonged exposure to light and air greatly affect the results of etherization, causing coughing, suffocation, and even dangerous after effects, such ether should always be tested for peroxides and aldehyde, and the presence of the latter should be rigorously guarded against, or the ether, if so contaminated, should be administered by a method which eliminates these impurities before it is introduced into the animal system.

We have made an examination as to the value of all proposed tests for the presence of impurities in ethyl ether, and have devised several new and superior ones. A scheme for examination has been worked out and is now available in the literature.[7]

CHLOROFORM

Liebig prepared chloroform from chloral. Soubeiran treated alcohol with "bleaching powder." Schering generated his "bleach" in the presence of alcohol by electrolysis. Then commercial methyl alcohol was used and "methylated spirit," whereby so-called "methylated chloroform" was obtained. Liebig also obtained chloroform by the action of "chloride of lime" upon acetone. Böttger and others used acetates (1848), and then chlorine was liberated in acetone by electrolysis. This process is used extensively in this country now. Methane of natural gas has been burned in chlorine, but this process has not proved successful commercially so far, although "gas chloroform" is spoken of by some in a wise way. Carbon tetrachloride, made by chlorinating carbon disulphide, is being reduced by the process of Smith to produce much chloroform in this country at present. "Chloral chloroform" is imported in small quantities.

From the variety of "Ausgangs-material" and different methods used it is quite evident that crude chloroform may contain a wide range of impurities, which may vary not only with the materials used but also with the conditions of manufacture. Alcohol has been removed from chloroform by washing with water, the chloroform being subsequently dried over calcium chloride. Potassium hydroxide has been used to remove excess chlorine and acids. Manganese dioxide has been employed to remove sulphur dioxide. Chloroform has been shaken with concentrated sulphuric acid until the acid was no longer colored; the vapors of chloroform have been passed through towers of crystallized sodium carbonate after treatment with sulphuric acid, and rectification has followed. To remove special impurities or decomposition products of the chloroform itself, chloroform has been treated with lead dioxide; with potassium permanganate, or

[7] Baskerville and Hamor, *loc. cit.*, **3**, No. 6, p. 395.

with dilute sodium thiosulphate; or it has been distilled over 2 per cent. paraffin or poppy oil. "Chloroform Anschütz" is obtained by distilling from crystals of salicylid-chloroform. "Chloroform Pictet" is made by chilling chloroform to —80° C., filtering off the solids produced, and then lowering the temperature to — 82° C. and drawing off the liquid impurities. The frozen chloroform is then fractioned, the intermediate 80 per cent. of the distillate being taken.

The specific gravity values of chloroform have been determined by different workers as follows:[8]

density permitted by the pharmacopœia. The samples of chloroform of German manufacture examined varied in specific gravity from 1.487 to 1.492 at 15/15°, although one sample possessed a density of 1.497 at this temperature. Since the correct specific gravity of chloroform is 1.49887 at 15/4°, those officials requiring chloroform of a lower density—that is, anesthetic chloroform—allow the addition of alcohol, and consequently the presence of small amounts of water; the permissible addition usually varies from 0.5 to 1 per cent.

Specific gravity determinations are not to be regarded as criteria of purity beyond indicating the amount of alcohol in chloroform.

TABLE I. DETERMINATIONS OF THE SPECIFIC GRAVITY OF CHLOROFORM

0°	11.8°	12°	15°	15.5°	16.5°	17°	18°	18.58°	25°	29°	35.86°	60.8°	61.2°	63°
1.52523	1.5039	1.496	1.485	1.500	1.472	1.491	1.48	1.48978	1.48432	1.49089	1.45695	1.4081	1.40877	1.3954
1.52657		1.512	1.4946			1.507			1.48492					1.4018
			1.4905											1.408114
			1.4976											
			1.5066											
			1.5107											
			1.4989											
			1.4980											
			1.500											
			1.50027											
			1.50085											
			1.49887											

In the course of an investigation on the decomposition of chloroform, we prepared *pure* chloroform.[9] This possessed a density of 1.49887 at 15/4° (average of six determinations), a result in close agreement with the values of Thorpe and Timmermans. This value may be taken as the correct specific gravity at the temperature noted.

The anesthetic chloroform on the American market varies in specific gravity from 1.4730 to 1.4827 at 25/25°, usually in close proximity to 1.476, the minimum

[8] A discussion of these values is given in an elaborate paper on "Chloroform" by the speaker and W. A. Hamor, which will appear in *J. Ind. and Eng. Chem.*, 3, No. 10.

[9] Baskerville and Hamor, *loc. cit.*

The boiling points of chloroform according to different observers are as follows:

BOILING POINT OF CHLOROFORM

Year	Observer	Temperature
1883	Schiff	60.9° at 754.3 mm.
1884	Perkin	62.0° at 760 mm.
1885	Bauer	61.0° at 760 mm.
1889	Thayer	61.6° at 760 mm.
1899	Pettit	61.97° at 760 mm.
1904	Wade and Finnemore	61.15° at 760 mm.
1911	Baskerville & Hamor	61.20° at 760 mm.

In general, it may be said that no specific directions are given for the determination of the boiling point and the influence of the variables (alcohol and water

in particular) has not received enough attention. Opinions are divided as to the value of the determination as a criterion of the purity of anesthetic chloroform. In the speaker's opinion, it is of no value without a knowledge of the content of alcohol and water. In making a careful fractionation of 500 g. of anesthetic chloroform made from acetone, containing 0.5 per cent. alcohol and 0.026 per cent. water, but otherwise pure, the temperature rose at once to + 55.5° C., at which point part of the alcohol and water with some chloroform passed over, the remainder of the alcohol with part of the chloroform going over between + 59.4° and + 61°. The following fractions were obtained:

Temperature	Weight of Fraction
55.5–59.4°	10 g.
59.4–61.0°	177 g.
61.0–61.2°	300 g.
Above 61.2°	13 g.

The influence of alcohol and water, separately or together, on the boiling point of chloroform may be seen from the following table.

BOILING POINTS OF MIXTURES OF CHLOROFORM, ALCOHOL AND WATER

Constituent	Boiling Point	Per Cent. Chloroform
1. Chloroform-alcohol-water	55.5°	92.5
2. Chloroform-water	56.1°	97.5
3. Chloroform-alcohol	59.4°	93.0
4. Chloroform	61.2°	100.0
5. Alcohol-water (95.5 per cent. alcohol)	78.15°	
6. Alcohol	78.3°	
7. Water	100.0°	

There has been not a little variety of opinion among chemists as to the nature and products of the decomposition of chloroform, especially the changes which chloroform undergoes upon exposure to air; in fact, this discordance dates from the introduction of chloroform as an anesthetic and prevails to-day. This condition is ascribable to the many influencing factors occasioned by the degree of purity of the chloroform under examination, the extent and nature of the exposure; but is principally due to the failure to consider, and therefrom to correctly interpret, the rôle of the general variable, alcohol, and with it the accompanying moisture.

The products of the decomposition of "pure" chloroform, according to various investigators, may be thus summarized:

Chlorine; hydrochloric acid	Morson; Maisch; Hager.
Carbonyl chloride	Rump; Regnault.
Carbonyl chloride; hydrochloric acid	Stark; Ramsay; Schoorl and Van den Berg; Dott.
Carbonyl chloride; chlorine	Brown; Schacht and Biltz; Adrian.

The formation of carbonyl chloride is alone definitely agreed upon.

The decomposition of chloroform has been universally conceded to be an oxidation process. It is generally accepted that chloroform is unaffected by light alone, and that light, although it accelerates oxidation, is not a necessary factor in the process; however, several investigators appear to have inclined to the view that light favors decomposition.

With regard to the changes which occur in anesthetic chloroform, that is, chloroform containing alcohol, during exposure to air and light, there also exists a decided diversity of opinion, principally owing to the fact that no examinations were made during the course of the various investigations, so far as we are aware, for the presence of the oxidation products of alcohol in such chloroform. The whole subject required investigation, and accordingly an experimental study of the decomposition of both pure and anesthetic chloroform was carried out. It was also hoped to

throw light on, if not fully explain, the rôle of alcohol[10] and other substances in the so-called preservation of chloroform, a satisfactory explanation of which has been wanting.

Various samples, some twenty-three in all, of both pure chloroform[11] and chloroform containing the usual pharmacopœial amounts of alcohol and water, were exposed, in well-stoppered[12] containers of various sizes, and containing varying amounts of the samples, and of both colorless and anactinic glass, such as are customarily used in the trade, for different periods of time, but at room temperature (20° C.), from September to May, inside of a window having direct southern exposure. The conditions were extreme, but nevertheless were similar to those obtaining in many pharmacies and hospitals.

The anesthetic chloroform used was examined prior to the experiments, and only such chloroform as was found to be free from impurities was used. However, an amount of water equivalent, on the average, to 5.1 per cent. by volume of the alcohol present was permitted.[13] Thus each sample was of pharmacopœial grade.

[10] The amounts of alcohol stated as permissible in the various official chloroforms intended for anesthetic purposes are as follows:

Belgium	1.0 per cent.
Denmark	1.0 per cent.
Sweden	0.5–1.0 per cent.
United States	0.6–1.0 per cent.
France	0.005 part by weight.
Italy	0.5 per cent.
Switzerland	1.0 per cent. absolute.

[11] This chloroform was prepared according to the method of Baskerville and Hamor and was absolutely pure.

[12] No cork stoppers unprotected by metal caps were employed. In the experiments on pure chloroform, glass-stoppered bottles were solely used.

[13] The alcohol content of the anesthetic chloroform used was determined quantitatively by the method of Nicloux.

The tests applied for the detection of the oxidation products of chloroform and alcohol were those previously proved out in our work. Quantitative determinations of the impurities developed were made when possible.

The experimental results warranted the following conclusions:

1. The products of the oxidation of *pure* chloroform are carbonyl chloride and hydrochloric acid, which come about according to these reactions:

$$CHCl_3 + H_2O + O_2 = COCl_2 + HCl + H_2O_2;$$
$$CHCl_3 + H_2O_2 = COCl_2 + HCl + H_2O.$$

We are convinced that oxidation will not occur if water be excluded, and the absolute exclusion of moisture appears to be impossible. Hydrogen dioxide is formed, although we have been unable to detect it in chloroform undergoing oxidation, and therefore conclude that its existence is ephemeral, and oxidation of the chloroform continues throughout the period of exposure. The rôle of the water is that of a true chemical catalyst. The decomposition of pure chloroform is accelerated by light, and carbonyl chloride is formed with increased readiness in the presence of acids.[14]

The extent of the oxidation is dependent upon the nature of the container, the amount of air present, the purity of the sample, and the intensity of the light to which it is exposed.

Free chlorine can only result from the photochemical decomposition of carbonyl chloride:[15]

[14] Cf. Lowry and Magson, *Trans. Chem. Soc.*, **93**, 121, who observed that the formation of carbonyl chloride is evidently accelerated by the presence of acids.

[15] In this connection, see Coehn and Decker, *Ber.*, **43**, 130; and Weigert, *Ann. Physik*, 1907, (4), **24**, 55. The influence of light on the reversible reaction, $CO + Cl_2 \rightleftarrows COCl_2$, is purely catalytic.

$$COCl_2 \rightleftarrows CO + Cl_2.$$

It is likely that in the cases where "chlorine" was identified as an indication of incipient alteration of chloroform, hydrogen dioxide was the cause of the reactions observed. No chlorine was found when containers of anactinic glass were used; and when chlorine is detected, it must be the result of a secondary reaction.

2. The products of the oxidation of anesthetic chloroform are primarily the oxidation products of alcohol, and no decomposition of chloroform itself occurs while the oxidation of alcohol proceeds. When the oxidation of alcohol reaches a maximum, decomposition of the chloroform goes on, as in the case of pure chloroform, with the exception that chlorinated derivatives of the oxidation products of alcohol may result. The decomposition of the chloroform itself is retarded, even prevented, so long as oxidation of the alcohol proceeds, and the retardation is consequently dependent upon the amount of alcohol present.

This leads to the rôle played by ethyl alcohol in the preservation of chloroform, for alcohol does prevent the decomposition of chloroform, as first suggested by Squibb in 1857 and later (1863) by Brown, independently.

Those who have investigated the part played by alcohol in preserving chloroform up to the present time have held that either chloroform decomposes in the presence of alcohol and that the alcohol takes care of the decomposition products or the alcohol acts as a "catalytic retarding agent" (Stadlmayr).

The preservative action of alcohol is due to the combination of the retarder with certain of the reacting substances; and any substance soluble in chloroform and readily oxidizable will exert an inhibitory effect on the oxidation of chloroform itself; for example, sulphur and many other substances.[16] All compounds which have been found to serve as preservatives of chloroform are reducing agents, and the effect is only due to their capacity for oxidation.

Anesthetic chloroform should preferably be furnished in vials or bottles of high-grade anactinic glass,[17] containing about the quantity sufficient for one narcosis, and at the most not more than can be used within several days. If, for any particular reason, chloroform is ordered in a large container, it is advisable, immediately after opening it, to subdivide the entire remaining contents into two-ounce bottles, taking care to fill the small bottles completely. It is important to see that the bottles are completely free from water, and empty bottles should not be refilled without thoroughly cleansing and drying them. In no case should chloroform be gradually withdrawn in small quantities from large bottles or carboys. When it is found necessary to store anesthetic chloroform, it should always be kept in a cool, dark place, in well filled, or, better still, completely filled, tightly stoppered bottles of anactinic glass.

The condition of officinal chloroforms which may be transported across the ocean and continent or kept at sea for variable lengths of time, where they would be subjected to constant agitation, has been investigated. Anesthetic chloroform in unopened, brown glass bottles were subjected

[16] Paper by Baskerville and Hamor, *loc. cit.*

[17] The glass should show no alkaline reaction when the bottle is filled with distilled water containing several drops of phenolphthalein solution and heated at 100° C. for six hours. On the action of alkalies on chloroform, see Berthelot, *Bull. soc. chim.*, (2), **29**, 4; Andre, *Compt. rend.*, **102**, 553; de St. Martin, *ibid.*, **106**, 492; and Mossler, *Monatsh.*, **29**, 573. It appears to be well established that potassium hydroxide in alcoholic solution will slowly decompose chloroform.

to intermittent agitation for over 200 hours in a Spiegelberg shaking apparatus, and it was learned from four samples so treated that it is desirable to prevent the presence of air, *i. e.*, oxygen, being in association with this anesthetic when it is to be shipped in the usual manner. Monneyrat devised a method of displacing air by nitrogen, even making a nitrogen siphon of chloroform.

The keeping qualities of anesthetic chloroform may be seriously affected by the character of containers. The question of keeping anesthetic chloroform in tin containers has been a much agitated one in the Federal War Department, and within the last ten years this department has decided in favor of the tin container.

The opinion of the author is that glass containers are more conducive to purity for several reasons. First, in cleaning the vessels any foreign matters present may be readily observed and the bottles properly cleaned. Second, in the case of tins, some of the flux used in soldering may be introduced and thus impart an acid reaction to the chloroform. Hydrochloric acid accelerates the decomposition of chloroform. The introduction of this flux is also a problem in ether manufacture which requires the utmost care. Third, since it has been stated that spirit containing 95 to 96 per cent. by volume of ethyl alcohol is perfectly indifferent to tin, and tinned metals are absolutely unattacked by 90 per cent. denatured spirit, the tinned metals only being corroded where the tin layer is broken,[18] one would conclude that acid-free chloroform,[19] containing the usual amounts of alcohol and water, would also be without action on tin, providing it is stored in tin containers having no broken or scratched surface, very carefully capped, and with a minimum amount of air. In order to determine this, a five-pound sample of chloroform, containing 0.84 per cent. by volume of absolute alcohol and approximately 0.05 per cent. of water, which had been stored in a tin container, sealed, for sixteen months, was examined for the presence of tin. This sample left a residue non-volatile at 100° C., amounting to 0.0220 g. per liter, but none remained upon ignition and no tin could be detected in the sample. The examination of a sample of anesthetic chloroform which had been kept in a sealed tin for six years also showed that no tin had been dissolved. In both cases, however, oxidation of the alcohol present had occurred, although no decomposition products of chloroform were present.

Fourth, we have been informed by H. H. Dow[20] that he has "demonstrated that moist chloroform in the presence of a metal will slowly form traces of CH_2Cl_2 and probably . . . that it is possible to distil pure, dry chloroform in a metal container and produce a decomposition as shown by the following formula:

$$4CHCl_3 + Cu_2 = C_2Cl_4 + 2CH_2Cl_2 + Cu_2Cl_2.$$

This reaction, however, takes place so slowly that it would never be noticed except in the handling of a material on which superlative efforts have been expended for years in order to get the last extreme of purity." Moreover, "all chloroform contains traces of CH_2Cl_2." In this connection, it should also be mentioned that it is probable that all metals which show anomalous anodic conductivity

[18] Heinzelmann, *Z. Spiritusind.*, **27**, 399. Malmejac, however (*J. Pharm. Chim.*, 1901, **13**, 169), found that a small amount of tin goes into solution in 95° alcohol after six months.

[19] On the action of hydrochloric acid in chloroform on tin, see Patten, *J. Physical Chem.*, **7**, 161, who found that the dry solutions act upon the metal less violently than upon zinc or aluminum, but more violently than on lead.

[20] Private communication.

are likely to develop free hydrogen dioxide in contact with water and oxygen;[21] in the speaker's opinion the presence of such metals should therefore be guarded against in the selection of a container for anesthetic chloroform.[22]

The *Pharmacopœia of the United States* formerly required the use of "glass-stoppered" bottles, but subsequently changed this to "well-stoppered" bottles, thus allowing the use of cork stoppers, a practise which has become general in this country.[23]

The objections which have been urged against the employment of cork stoppers are two in number. First, the chloroform penetrates the cork after some time, especially during the agitation incidental to shipment, causing shrinkage and perhaps consequent leakage.[24]

The second objection is that organic matter is extracted from the cork and the chloroform fails when the sulphuric acid test, a test used for the detection of fusel oil, chlorinated decomposition products, etc., is applied. To obviate these difficulties, certain manufacturers of chloroform have adopted the plan of covering the bottom of corks with tin foil, a procedure which so far has been found to be satisfactory, but which may be open to some of the objections to tin containers. Other manufacturers use a paper or parchment covering, and still others select only the best corks and extract them thoroughly with chloroform before use.

The impurities which anesthetic chloroform brings with it from the manufacturer, the so-called "organic impurities," are traceable to the materials used in the making, method of manufacturing, subsequent purification, and manipulation before marketing; these may be grouped into one class (A). Another class (B) includes those impurities developed during different conditions of storage.

These impurities, even though some may not be of much importance from a physiological standpoint, must still be given attention, since an impure chloroform is more likely to become altered through oxidation during storage, notwithstanding the fact that pure ethyl alcohol has been added. So far as we have been able to learn, the adulteration of anesthetic chloroform is not practised now, and crude chloroform is no longer sold as chloroform of anesthetic grade.

You are spared a discussion of the numerous tests for the various impurities which may be present in anesthetic chloroform, as these will soon be available in one of our papers. Suffice it to say that in our laboratory we have studied every test we have been able to find in the literature and have been forced to devise new ones in some cases, while in others we are unable to make any recommendations at all as

[21] Barnes and Shearer, *J. Physical Chem.*, **12**, 155, 468.

[22] All of the manufacturers of chloroform in this country use brown glass ("anactinic") bottles. Of the eight different makes of German chloroform examined by the speaker, only two were contained in colorless bottles.

[23] In Germany, however, glass stoppered bottles are used by prominent producers of anesthetic chloroform (Kahlbaum; de Haen; Merck; "A.-G. für Anilin-Fabrikation," etc.).

[24] Allain [*J. Pharm. Chim.*, (3), **9**, 571] and Masson [*Ibid.*, (6), **9**, 568] have recommended that when chloroform is kept in cork-stoppered bottles, a lute of "bichromate gelatin" should be used to prevent leakage. This is unnecessary when a proper stopper is used, and the employment of lutings on the stoppers has led to many differences between the manufacturer and consumer in the past. Only one of the many samples of anesthetic chloroform examined by the authors was contained in a bottle having a luted cork stopper, and in this case considerable organic matter had been taken up, and, as a result, the chloroform failed to comply with the important sulphuric acid test or confused its interpretation.

yet. Two illustrations may prove of interest. Paraffin oil, sp. gr. 0.88, may be used to discriminate between 0.08 and 0.09 per cent. of water in chloroform, but it does not show the presence of a smaller amount. We were not aware of any test having been devised to show the presence of less than 0.05 per cent. of water in chloroform until we found that clean crystals of calcium carbide would answer most satisfactorily.

Carbon tetrachloride boils at + 78.1° C. and has a specific gravity of 1.63; chloroform boils at + 61.2° C. and has a specific gravity of 1.4989. A binary mixture containing 7.8 per cent. carbon tetrachloride boils at + 62° C. From what has been said of the presence of the variables, alcohol and water, in anesthetic chloroform and their influence upon the physical properties of chloroform, it will be quite evident that determinations of these physical constants can be of little real value, and their application in general practise, even in well equipped laboratories, is quite out of the question. All our efforts to secure a method applicable on a laboratory scale to detect likely amounts of carbon tetrachloride in chloroform have been unsuccessful. To be sure carbon tetrachloride possesses anesthetic properties, but it must exert its own specific physiological effect and the anesthetist should know the drug he uses.

Among the anesthetic mixtures, the combination of chloroform vapor with oxygen was used shortly after the introduction of chloroform as an anesthetic, and it has recently been reintroduced into practise. Hence it was important to investigate the changes which anesthetic chloroform undergoes when a current of oxygen is conducted through it. Dr. J. T. Gwathmey[25] has recently stated that oxygen increases the value of all inhalation anesthetics as regards life.

[25] The speaker has been collaborating with Dr. Gwathmey, who has directed the clinical observations.

Several experiments were carried out in order to determine whether the passage of a current of oxygen through anesthetic chloroform brings about decomposition of the anesthetic. Anesthetic chloroforms containing 0.56 to 1.0 per cent. of alcohol and 0.03 to 0.05 per cent. of water were used. The conditions were such, except that the temperature was about + 20° C., as obtain during administration by the Gwathmey method, his apparatus being used. The oxygen was allowed to flow at such rates through 3½ to 4 ounces of the anesthetic that about one-half remained in the vaporizer after 3½ to 10½ hours. In one experiment the chloroform vapor was passed through water, as is Dr. Gwathmey's practise, and subsequently condensed. The examination of the residue and condensed chloroform showed the following:

Acidity (acetic acid):	
Chloroform used	None.
Residue in container	0.00015 g. in 100 c.c.
Condensed chloroform	None.
Sulphuric acid test:	
Chloroform used	Negative.
Residue in container	Marked reaction.
Condensed chloroform	Negative.

Therefore it was concluded that the oxidation products of alcohol are not carried over when the chloroform-oxygen stream is conducted through water, and that these are concentrated in the residue. By this method of administration the patient is protected from the objectionable decomposition products even if they had developed. Furthermore, the vapors of the anesthetic so applied are saturated with water, hence can not exert that desiccating effect upon the mucous membranes they would if not moisture-laden.

OXYGEN

As animadverted, ninety-four years after the discovery of nitrous oxide and oxygen by Priestley, they were first used in combination for anesthetic purposes. Although Andrews published accounts of several cases, in which, by mixing oxygen with nitrous oxide, he had obtained a more satisfactory form of anesthesia than with nitrous oxide alone, his observations failed to attract the attention they deserved. Ten years later (1878) Paul Bert drew further attention to this form of anesthesia. Hewitt[26] stated previous to the completion of the work reported this morning, that the most recent and best development in modern anesthetics is the combination of oxygen with nitrous oxide whereby a non-asphyxial and safe form of anesthesia may be produced. The results of a long series of experiments with various anesthetics and different mixtures caused Gwathmey to say "Oxygen is indicated with every anesthetic and at all times. The longer the anesthesia, the more urgent is the call for oxygen by the blood." The importance of the quality of the oxygen is apparent.

At the present time, there are the following methods of preparation and manufacture of oxygen:[27] (1) heating chlorates; (2) heating chlorates with various substances; (3) from hypochlorites and reaction of chlorine and water; (4) heating sulphuric acid or sulphates; (5) heating various solids and mixtures (MnO_2, CuB_4O_7, etc.); (6) combustion of solid mixtures (chlorates with combustible material, alkaline peroxides with hydrated salts, etc.); (7) reaction of peroxides (oxone) with water and aqueous solutions; (8) by electrolysis of water; (9) from the air by means of mercury, cuprous chloride, barium dioxide, manganates, plumbates, or living matter, or by dialysis or absorption; and (10) from liquid air.

Oxygen that is to be used in anesthesia should contain at least 95 per cent. O_2 upon the dry basis. We found that the pyrogallate method is the most convenient method to employ and most satisfactory, provided Hempel's[28] precautions to prevent the production of carbon monoxide are taken.[29]

Analyses, by our methods, of oxygen on the American market gave the following results:

No.	Source of Oxygen	O_2	H_2O	CO_2	H_2	Organic Matter	N_2, etc.	All other Impurities
1	$KClO_3+MnO_2$	93.20	0.30	0.11	0	0	6.39	0
2	$KClO_3+MnO_2$	98.31	0.14	present	0	0	1.54	0
3	$KClO_3+MnO_2$	92.82	0.26	trace	0	0	6.92	0
4	$KClO_3+MnO_2$	97.13	0.23	present	0	trace	2.63	0
5	Liquid air	96.10	0.15	0.01	0	0	3.74	0
6	Electrolysis	99.23	0.35	0.03	0.14	0	0.25	0
7	$Na_2O_2+H_2O$	99.20	0.50	trace	0	0	0.30	0

CONCLUSIONS

I realize the danger of a mere chemist making an excursion into the field of medicine, but the extremely venturous one, if he has luck, may be swept by the rocks of which he knows little. I ventured in, as I was unhampered by tradition, and I have done enough in this field to make me take a theoretical plunge.

Modern studies in physiology have unquestionably shown that the animal body exists to a great extent by virtue of the chemical and physical changes going on within it. I know of no valid reason for assuming

[26] "Anæsthetics," The Macmillan Co.

[27] Baskerville and Stevenson, *J. Ind. and Eng. Chem.*, **3**, 471.

[28] Hempel, "Gas Analysis," English translation by Dennis, 1906, p. 149.

[29] Commercial oxygen as supplied in the trade has been quite thoroughly investigated by the speaker and Stevenson, *loc. cit.*

that these changes are essentially different from those we control in the laboratory. If we wish to control a physical or chemical change in the laboratory, we endeavor to become familiar with all the factors and conditions. If we seek to duplicate, we try to duplicate the conditions. I know of only one class of such changes over which we have not as yet secured control, and in that class belongs those processes which we term radioactive. One of the essential factors in controlling a chemical process is the quality of the material with which we are working. I can not, therefore, but regard all published statistics as to the mortality attributed directly to the anesthetic used as more or less worthless, and that a large number of new cases must be observed to secure knowledge of the real physiological effect of the drug when carried into the system by the pulmonary route.

Impure foods, sophisticated intentionally or otherwise, may bring on disease. Impure drugs, concocted or otherwise, fail to produce the full effect planned by the physician in curing disease.

Idiosyncrasy has served to account in large part for untoward after-effects of anesthetics and certain disagreeable consequences, as nausea; and interference with some normal organic functions, as glycosuria and albuminuria, have often been regarded as natural results of anesthesia, and taken for granted. They may now be largely obviated and in many cases entirely avoided by the use of anesthetics that are free from impurities, and by improved methods of administration. These statements are based upon clinical evidence. We now have records of 5,000 cases.

The main objectionable impurity in ether is acetaldehyde. American official ethers call for three to four per cent. of ethyl alcohol in accordance with an old and erroneous theory that alcohol protected the ether. Alcohol is practically never free from water, and in the presence of water and oxygen forms oxidation products. The speeds of the changes depend upon conditions. It has been shown that the administration of moist ether, free from aldehyde, at body temperature, is rarely followed by nausea (less than ten per cent.) and the usual strain upon the kidneys is not observed.

Chloroform was formerly made mainly from alcohol and contained many of the normal impurities of the alcohol used. These were not removed by the methods of purification practised, nor are they totally removable, except by elaborate methods of purification. These impurities doubtless have had much to do with the feeling of uncertainty in administering chloroform. Pure chloroform undergoes decomposition when exposed under certain conditions, such, for example, as the manner in which anesthetic chloroform is dispensed in some drug stores and hospitals. A suitable amount of alcohol prevents this decomposition, shunting the change in composition to itself, hence anesthetic chloroform should contain ethyl alcohol. But the conditions of transportation and keeping of this chloroform should be such as to reduce the change of alcohol to aldehyde and acetic acid to the minimum.

Nitrous oxide, ether and chloroform, each exerts its specific physiologic effect in producing anesthesia without asphyxiation, provided the respiratory and cardiac functions are approximately normal. This may be and is being accomplished by administering these gasified drugs with sufficient oxygen not to interfere seriously with the normal function of the hæmoglobin of carrying oxygen to the capillaries and sustaining cardiac stimulation, and by maintaining the usual concentra-

tion of carbon dioxide in, and providing its regular elimination from, the blood; for it is the respiratory stimulant (Yandall Henderson). Other factors involved are temperature and moisture. The anesthetics are carried into the system at body temperature. This may be and is being accomplished by warming, and, in the case of ether and anesthetic chloroform, by passing the vapor through heated water, which, at body temperature, not only removes the oxidation products, but saturates the gas with moisture (Gwathmey method). The osmotic action of the alveolar cells is thus affected only to the extent of the densities of the gases introduced into the lungs, and not, as normally is the case, by temperature (always lower) and desiccation as well. In other words, by the application of the principles of modern physical chemistry, the numerous variables are so reduced as to secure the real physiological effect of the particular anesthetic drug after it enters the system. Nitrous oxide and oxygen may be used for prolonged anesthesia and successfully for eighty per cent. of surgical cases; furthermore, ether and chloroform may be used with equal safety. The real, and no supposititious, idiosyncrasy of the patient may be met. The expert anesthetist may now not only make it possible for the surgeon to perform even greater miracles, but with more comfort to himself in his work, and with greater happiness and less discomfort to the patient.

CHARLES BASKERVILLE
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CYRUS GUERNSEY PRINGLE

IN 1882 I had the pleasure of accompanying Dr. C. C. Parry and C. G. Pringle on a botanical expedition into Lower California. At this time Mr. Pringle was engaged in forming the Jesup collection of American woods for the American Museum of Natural History, and this was his first trip into Mexican territory, as it was my first.

The personal instruction given me at this time, and many following favors in after years, cemented our friendship. Previous to this time Mr. Pringle was principally known as the originator of the snowflake potato, and of new varieties of wheat and oats, and his labors in this field have added many millions to the profits of the American farmer. To him Luther Burbank owes the first training that he received in originating new varieties of plants, and many others could no doubt testify to the helpfulness of the man, ever above the petty jealousies that beset some lives.

The next twenty years passed without my again meeting the man in person, when we met in Mexico City, and I journeyed with him into many fields of botanical interest—the lava fields near that city, and to the grand barrancas near Guadalajara—replete with discoveries which render his name inseparable from the annals of American botany.

Mr. Pringle carried consideration for others almost to an extreme (were this truly possible), and I have seen him select the heavier burden and give his peon servant the lighter one to carry.

In asking for data concerning his life I received the following reply: "I decided that it was hardly possible for me to comply with your request. It would be too painful to write my autobiography. Shyness has become habitual with me. Besides my aversion to publicity, I am too busy to write much. All my thought and labor goes to the building of a great and superior herbarium."

His choice of a monument is the herbarium of the University of Vermont, which bears his name. His death from pneumonia, on May 26, 1911, aged seventy-three years, was announced in the daily press.

A rich man—who has created millions—not for himself, but for his fellow man.

C. R. ORCUTT

STUDENTS IN THE GERMAN UNIVERSITIES[1]

Since the establishment of the empire the number of students at the German universities has regularly risen from about 13,000 until in the middle of the 80's it had already doubled and the threatened overcrowding of academic pursuits was recognized. The German student body tripled its original number by 1904, and reached in the current summer 57,230 as compared with 54,847 in the previous year. Of the entire number of students to-day 54,678 are men, 2,552 women; of these at present about 53,000 belong to the empire and about 4,300 are foreigners. A comparison of the figures for the different departments for the present and previous year and for 1906 shows what changes in the direction of studies have occurred in consequence of the influence of the needs of the state and society and especially what occupations are favored. In this respect the rapid growth of medicine as a profession is striking, the number of medical students rising from 6,683 in 1906 to 10,682 last year and now to 11,927. Nearest to them stand the students of philosophy, philology and history who number at present 16,158 as compared with 15,475 and 10,832; mathematics and natural science, 8,442 (last year 7,937, in 1906, 6,323); law, 11,023 (11,323 and 12,375); evangelical theology, 2,825 (2,507 and 2,329); of catholic theology, 1,834 (1,840 and 1,841); political economy and agriculture, 2,729 (2,406 and 1,801); pharmacy, 916 (1,147 and 1,767); dentistry, 1,046 (1,264 and 755); forestry—only matriculated in Munich, Tübingen and Giessen, 170 (123 and 114), and of veterinary surgery—only matriculated in Giessen 160 (141 and 114). According to this the number of law students has diminished in consequence of the overfilling of the profession and this is still more the case with pharmacy. The recent reduction in the number of dental students is to be attributed to raising the entrance requirements and the lengthening and increase in cost of the course.

[1] From the *Journal* of the American Medical Association.

Of the present student body 28,981 are enrolled at the ten Prussian universities as compared with 27,577 in the summer of 1910. At the three Bavarian there are 9,445, last year, 9,369; at the two Baden, 5,532 (1910, 5,279), and in the other six state schools, including the imperial at Strasburg, there are 13,222 as compared with 12,602 in 1910. The university of the metropolis stands at the head, having at present 8,039 students, including 695 women, as compared with 7,902 and 626 last year.

All the universities except Giessen have gained this year, most markedly Greifswald, Kiel, Rostock and Halle, and least, Heidelberg, Münster and the three Bavarian universities.

THE ASTRONOMICAL FELLOWSHIP OF THE NANTUCKET MARIA MITCHELL ASSOCIATION

The Nantucket Maria Mitchell Association offers an astronomical fellowship of one thousand dollars, to a woman, for the year beginning June 15, 1912, under the following conditions: The year shall be divided into two periods, approximately as follows: June 15 to December 15 on Nantucket, where the observatory is equipped with a five inch Alvan Clark telescope. This period shall be occupied in observation, research or study, and in lectures or instruction to classes or individuals. February 1 to June 15 at one of the larger observatories. This semester shall be occupied in original research and study. During this period a distinct plan for the following Nantucket period shall be formulated. Every fourth year the fellowship shall be available during the entire year for study at one of the larger observatories in Europe or America. The fellowship will be awarded annually, but in order that the work at Nantucket may be combined advantageously with the work at the selected observatory, the preference will be given to the same candidate for three successive years. This candidate shall have first consideration among applicants for the special quadrennial appointment. A competitive examination will not be held. The

candidate must present evidence of qualifications under the following heads: (1) A letter from the candidate addressed to the secretary of the committee, giving an account of previous educational opportunities and training, and of plans for future work. (2) College diploma or a certificate from the registrar of her college, and if she has already held a position as instructor or teacher in any college or other institution, a clear statement of the work done, together with a certificate as to the quality of work. (3) Examples of work already accomplished. (4) Testimonials as to ability and character. (5) Satisfactory evidence of thoroughly good health. The fellowship at all times must be used for purposes of serious study, and the fellow should be as free as possible from other responsibilities.

Application for the year beginning June 15, 1912, should be made under the above heads, and must be in the hands of the secretary of the committee, Mrs. Charles S. Hinchman, 3635 Chestnut Street, Philadelphia, Pa., on or before March 1, 1912. The committee consists of Professor Mary W. Whitney, director of Vassar College Observatory, *chairman;* Annie J. Cannon, A.M., Harvard Observatory, *vice-chairman;* Professor Anne S. Young, Ph.D., Mt. Holyoke Observatory; Dr. Edward C. Pickering, director of Harvard Observatory; Elizabeth R. Coffin, A.B., Vassar College, '70; Florence M. Cushing, A.B., Vassar College, '74; Lydia S. Hinchman, Philadelphia, *secretary.*

SCIENTIFIC NOTES AND NEWS

The Vienna Academy of Sciences has elected as honorary members Professor Svante Arrhenius, of Stockholm; Professor Archibald Geikie, of London, and Professor E. Metchnikoff, of Paris.

Professor E. Cosserat, director of the observatory at Toulouse, has been elected a corresponding member of the Paris Academy of Sciences.

The Paris Academy of Medicine has elected as national associates Dr. de Brun, professor of pathology at Beirut, and Dr. Herrgott, professor of clinical obstetrics at Nancy.

The celebration of the seventieth birthday of the Königsberg pharmacologist, Professor Jaffé, took place on July 25.

The Middlemore prize of the British Medical Association has been presented to Mr. C. W. G. Bryan in recognition of his essay on serum and vaccine therapy, in connection with disease of the eye.

Mr. Harlan I. Smith, of the American Museum of Natural History, has been appointed archeologist of the Geological Survey of Canada, with an office in the Victoria Memorial Museum, the national museum of Canada, at Ottawa.

At the recent meeting of the American Ophthalmologic Society at New London, Dr. Edward Jackson, of Denver, was elected president.

The following honorary degrees were conferred at the ninety-first commencement of Colgate University: L.H.D. on John Burroughs, the naturalist; Sc.D. on H. E. Slaught, Ph.D., professor of mathematics, University of Chicago, and John B. Ekeley, Ph.D., professor of chemistry, University of Colorado.

The Dutch geologist, Dr. Molengraaf, has lately undertaken an investigation of the interior of Timor.

The eighteenth Congress of Americanists will be held next year in London, the invitation issued by the Royal Anthropological Institute, through its president, Mr. A. P. Maudslay, having been accepted by the congress. The president-elect is Sir Clements Markham.

The fourteenth annual session of the American Mining Congress is called to meet at Chicago, Ill., on September 26, 27, 28 and 29.

The Michigan Health Board of Exhibit started on its first trip over the state on August 1, promulgating facts regarding typhoid fever, tuberculosis, infant mortality and general sanitation to the people of the state.

By the will of the late Dr. J. Smith, of Hanover, Pa., he devised his entire estate,

valued at about $50,000, toward the endowment of a library for Hanover. A citizen of the town has given a building, which is just completed and the local physicians have undertaken to develop a medical reference section as a memorial to Dr. Smith.

The *Scottish Geographical Magazine* states that the annual relief of the observers located at Laurie Island, South Orkneys, was effected early in February by the *Uruguay*, which experienced very heavy weather, both on the outward and homeward voyage. The observers report a very open autumn and winter as having occurred last year—May, June and July being all milder than any noted previously. The first zero temperature was not observed till July 24, or three months later than in 1903, when the *Scotia* was frozen in by the end of March. In 1910 Scotia Bay remained unfrozen till the last week of July, being the latest date observed, and broke up on November 18. August was a cold month. During the summer of 1910–11 there was much pack ice round the islands, which did not disperse till early in February, a few days before the arrival of the relief ship. Mr. Elliston, a Norwegian, one of the meteorological observers, died on August 20 of a cardiac complaint after a few weeks' illness.

The president of the British local government board has, as we learn from the *Journal* of the American Medical Association, authorized the following special researches to be paid for out of the annual grant voted by parliament in aid of scientific investigations concerning the causes and processes of disease: (1) A research into the causes of premature arterial degeneration in man, by Dr. F. W. Andrewes, pathologist to St. Bartholomew's Hospital; (2) an inquiry by Dr. J. H. Thursfield, of St. Bartholomew's Hospital into the causes of death in measles; (3) a comparison by Professor Nuttall, F.R.S., Quick professor of biology at the University of Cambridge, of the number and kinds of fleas found on rats; (4) a continuation by Dr. C. J. Lewis, of Birmingham University, of his investigation into the degree of prevalence and the characteristics of microorganisms known as non-lactose fermenters in the alimentary canal of infants; (5) an investigation into the same subject by Dr. D. M. Alexander, of Liverpool University; (6) an inquiry by Dr. Graham Smith, of Cambridge University into the incidence of non-lactose fermenters in flies in normal surroundings and in surroundings associated with epidemic diarrhœa; (7) a study by Dr. F. A. Bainbridge, of the Lister Institute, of the anaerobic bacteria in the alimentary canal of infants; (8) an investigation by Dr. Graham Smith into the possibility of pathogenic microorganisms being taken up by the larva and subsequently distributed by the fly.

We learn from *Nature* that the organizing committee of the fourth International Conference of Genetics, to be held in Paris on September 18–23, met recently under the presidency of Dr. Viger. M. Philippe de Vilmorin, secretary of the committee, reported what had been done up to that day in preparation for the conference. Not counting the names of the principal French biologists who are members of the committee, the secretary was able to give the names of the following foreigners who have subscribed: Baur, Giesenhagen, Goldschmidt, Pfitzer, Poll, etc. (for Germany); Agar, Bateson, Darbishire, Gregory, Miss Durham, Hartog, Laxton, Lynch, Nettleship, Paton, Punnett, Miss Saunders, Staples-Browne, Sutton, Miss Wheldale, etc. (for Great Britain); Bradley (for Australia); Fruwirth, Strakosh, Tchermak, etc. (for Austria); W. and Chs. Saunders (for Canada); Johannsen (Denmark); Balls (Egypt); Davenport, Hays, Howard, Swingle, Tower, etc. (United States); Hagedoorn, Houwink, Lotsy, Noordnijn (for Holland); Leake (for India); Strampeli (for Italy); Nilsson-Ehle, Rosenberg (for Sweden); Chodat (Switzerland); Boris de Fedtschenko (Russia), and Arechavaleta (Uruguay). Many universities and scientific societies will be officially represented. Numerous communications have been promised; short descriptions of them will be published before the meeting of the conference, and they will be published in full in the proceedings, a copy of which will be sent to

each subscriber. The meetings of the conference will depend upon the number of the communications, but it seems probable that five sittings will be sufficient. The remaining time will be devoted to visits to the Museum of Natural History, the Pasteur Institute at Garches, to Verrières, the laboratories of the Sorbonne, etc. Probably there will be a reception by the French National Society of Horticulture on September 18, and one at the Hôtel de Ville on September 23.

When congress, in order to encourage the building of the great transcontinental railroads, subsidized them by land grants of enormous areas along the lines to be built, certain restrictions were made as to the character of lands which were thus granted. Thus the land grant of the Northern Pacific excepted all mineral lands other than those containing coal and iron, these minerals being excepted because they would be of use in the building and maintenance of the road. After the grant was made it became necessary to determine what parts of these lands were mineral and should therefore be retained by the government. A classification of the lands included within the Northern Pacific grant in the Bozeman, Helena and Missoula land districts, in Montana and in the Cœur d'Alene district, in Idaho, was accordingly required by the Act of Congress of February 26, 1895, which provided that the classifications should be made by three commissioners in each land district. In the sundry civil Act of June 25, 1910, an appropriation of $30,000 was made to enable the commissioner of the General Land Office to complete the examination and classification of lands within the Northern Pacific grant in this territory. The additional classification was made by geologists of the Geological Survey. As a result of the work done 288,545 acres were examined and classified during the year. Of this area 112,514 acres were classified as non-mineral and may therefore properly be patented to the Northern Pacific Railroad. On the other hand, 176,031 acres were classified as mineral land, either because the lands examined were found to contain valuable deposits of gold, silver, lead, phosphate or other important minerals, or because the geological and other indications warranted the prospecting of the lands for valuable minerals. Lands that are finally held to be mineral will remain in the public domain for entry and development by private enterprise. The potential value of the minerals included in these lands has not been fully estimated, but it is certainly very great.

UNIVERSITY AND EDUCATIONAL NEWS

The dean of the Wisconsin College of Physicians and Surgeons, Milwaukee, announces that an anonymous benefactor has given $5,000 to the maintenance fund of the college.

The trustees of Indiana University have appointed Dr. Charles P. Emerson as dean of the Indiana University School of Medicine, and head of the department of medicine. He will take up his residence in Indianapolis, the first of September, and will enter on his teaching and executive duties at the beginning of the fall term. It is definitely agreed that his first duties shall be to the university, and that consultations, to which his practise will be limited, shall be strictly secondary to these.

Dr. M. A. Rosanoff, since 1907 acting head of the department of chemistry in Clark University, has been made full university professor and head of the department.

Mr. Paul Hayhurst, assistant entomologist at the Arkansas Experiment Station, has been promoted to the full title of entomologist at the station and professor of entomology in the University of Arkansas with Mr. George G. Becker as his assistant. Mr. Hayhurst thus succeeds Dr. C. F. Adams, dean and director, who was formerly the entomologist.

Dr. Heinrich Biltz, associate professor at Kiel, has been called to the chair of chemistry at Breslau.

Professor Rössler, of Munich, has accepted a call to Jena as professor of pathologic anatomy.

DISCUSSION AND CORRESPONDENCE

THE PYTHAGOREAN THEOREM

TO THE EDITOR OF SCIENCE: In your journal for December 16, 1910, Dr. Northrup asks whether a dynamical investigation which he there gives is a proof of the Pythagorean theorem; and in the number for March 24, the question is discussed by Professor Deimel and Mr. Hersey. Looking at the question from the point of view of vector-analysis, or rather of the algebra of space, I would answer, Yes. Dr. Northrup starting from the principle of kinetic energy and certain other principles of dynamics deduces two expressions for the kinetic energy of the system shown in his diagram; and from the equivalence of these expressions he deduces the forty-seventh proposition of the first book of Euclid, commonly called the Pythagorean theorem; but he could with ease deduce the more general proposition (Euclid II., 12 and 13) which expresses the side of any plane triangle in terms of the other two sides and their included angle. His proof is merely the reverse of the following reasoning. I look upon the x, y, R, r and $-r$ of his diagram as vectors. The kinetic energy of the first mass is $\frac{1}{2}m(xW)^2=\frac{1}{2}mW^2x^2$; and similarly that of the second mass is $\frac{1}{2}mW^2y^2$. But

$$x^2=R^2+r^2+2\cos Rr$$

and

$$y^2=R^2+(-r)^2-2\cos Rr$$

where $\cos Rr$ denotes the rectangle formed by R and the projection of r along R. Hence

$$\begin{aligned}\tfrac{1}{2}mW^2(x^2+y^2)&=\tfrac{1}{2}2m(R^2+r^2)W^2,\\&=\tfrac{1}{2}2mR^2W^2+\tfrac{1}{2}2mr^2W^2\end{aligned}$$

Here we pass from the one to the other expression for the kinetic energy of the system by means of the extended Pythagorean theorem; on the other hand, Dr. Northrup can deduce from the two expressions for the kinetic energy of the system the truth of this geometrical theorem.

This same principle that $E=\frac{1}{2}mv^2$ has an important bearing on the fundamental principles of vector-analysis: it places the orthodox quaternionist in a corner from which there is no escape. Because E is assumed in mathematical analysis to be positive and $\frac{1}{2}m$ is positive, it follows from the established principles of analysis that v^2 must be positive; consequently, to hold that the square of a simple vector is negative is to contradict the established conventions of mathematical analysis. The quaternionist tries to get out by saying that after all v is not a velocity having direction, but merely a speed. To this I reply that

$$E=\cos\int mvdv=\tfrac{1}{2}mv^2,$$

and that in these expressions v and dv are both vectors having directions which in general are different.

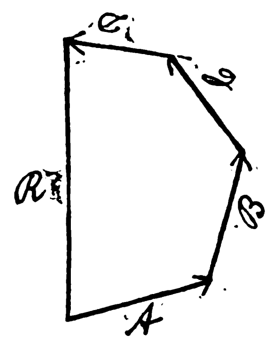

FIG. 1.

Recently (in the *Bulletin* of the Quaternion Association) I have been considering what may be called the generalization of the Pythagorean theorem. Let A, B, C, D, etc. (Fig. 1), denote successive vectors having any directions in space, and let R denote the vector from the origin of A to the terminal of the last vector; then the generalization of the Pythagorean theorem is

$$\begin{aligned}R^2=A^2+B^2+C^2+D^2&+\\+2\{\cos AB+\cos AC+\cos AD&+\}\\+2\{\cos BC+\cos BD&+\}\\+2\{\cos CD&+\}\\&+\text{ etc.}\end{aligned}$$

where $\cos AB$ denotes the rectangle formed by A and the projection of B parallel to A. The theorem of Pythagoras is limited to two vectors A and B which are at right angles to one another, giving $R^2=A^2+B^2$. The extension given in Euclid removes the condition

of perpendicularity, giving $R^2 = A^2 + B^2 + 2\cos AB$. Space geometry gives $R^2 = A^2 + B^2 + C^2$ when A, B, C are orthogonal, and $R^2 = A^2 + B^2 + C^2 + 2\cos AB + 2\cos AC + 2\cos BC$ when that condition is removed.

Further, space-algebra gives a complementary theorem, never dreamt of by either Pythagoras or Euclid. Let V denote in magnitude and direction the resultant of the directed areas enclosed between the broken line $A + B + C + D$ and the resultant line R, and let $\sin AB$ denote in direction and magnitude the area enclosed between A and the projection of B which is perpendicular to A; then the complementary theorem is

$$\begin{aligned} 4V = 2\{\sin AB + \sin AC + \sin AD +\} \\ + 2\{\sin BC + \sin BD +\} \\ + 2\{\sin CD +\} \\ + \text{etc.} \end{aligned}$$

ALEXANDER MACFARLANE

CHATHAM, ONTARIO

A BRIGHT AURORA OF SEPTEMBER, 1908[1]

THE finest display of the aurora borealis seen by the writer in Omaha during the last twelve years, took place on the night of Monday, September 28, 1908. Before describing its appearance, it may be of interest to mention the weather conditions that preceded and accompanied it.

No rain had fallen for about five weeks, the temperature during the day time had been unusually high, and strong winds had filled the air with disagreeable clouds of dust. The long duration of this state of the weather had become very monotonous. The expected clashing of a low from the northwest and of a West Indian storm from the southeast, had failed to bring any relief. Another week passed, and after an occasional cloudiness of the sky and an increasing humidity of the air had only tantalized this section of the country with unredeemed promises of moisture, the rain came at last and with it a rapid and great reduction of temperature, the thermometer fell from the eighties in which it had been hovering down to ten degrees above the freezing point. Monday, the day of the auroral display, opened with a temperature of about 40 degrees and a cold and disagreeable rain. It was still cloudy and misty at noon, but at about three o'clock the sky cleared, the wind came from the northwest, and the night began with a quiet, cloudless, cold and most transparent sky. An occasional glance at the heavens could detect no indications of an aurora. It was noticed rather suddenly at about 9:50 P.M. It then appeared as an arch extending from the northwest to the northeast horizon, and was about 8 degrees high on the meridian. Below the arch was a well-defined black space of uniform tint, which might easily have been taken for a bank of clouds. The arch itself was of a beautiful, soft, silvery whiteness, and seemed to be about 5 degrees in width. Its upper limit was not quite as distinct as its lower one. At this time there were no streamers of any kind, nothing but the arch. There was no moon to interfere with the display as it was seen from the observatory, and the city lights were also far enough away not to blind the eyes of the observer.

In about a quarter of an hour the scene changed. A few detached streamers now began to make their appearance, like the softened beams of search lights below the horizon. They were from about two or three to 20 or 30 degrees in length, and from one fourth to about 4 degrees in width. The short beams seemed to come directly out of the ground and were visible against or through the black space below the arch, and the longer ones passed visibly even through the bright arch itself. They did not seem to have any perceptible lateral motion, but they all seemed to come from the same vanishing point, which was estimated to be about 50 degrees below the horizon and on the meridian. The largest and broadest streamer was in the northwest, at the very end of the arch. It was about four degrees wide and 20 degrees long, and of a decided blood-red tint. A few of the other

[1] This excellent description was originally sent to the *Monthly Weather Review*, but is transferred to SCIENCE, as it belongs to cosmical physics rather than to climatology, to which the *Monthly Weather Review* is now confined.—Cleveland Abbe.

beams also showed the same tint, but most of them were of a faint silvery whiteness. They lasted from a few seconds to several minutes.

The arch gradually spread along the horizon until it covered 120 degrees or more, and at the same time ascended the meridian to the height of 15 or 20 degrees.

Then there were two parallel arches separated by a dark space, each arch and the dark space being about five degrees wide. Stars of the first three magnitudes could be seen equally through the bright and dark portions. Even in the group of the Hyades about Aldebaran the stars could be seen through one of the brightest portions of the display.

The upper arch then gradually broke up, its detached pieces appearing like floating clouds. They slowly drifted higher in the sky, until they seemd to be parts of a broken arch which extended from the west to the east points of the horizon. While these detached portions floated away, there seemed to be no streamers, as if streamers and broken arches could not exist together, but of this the writer is not certain, although he wrote down his observations at the first opportunity that presented itself the following morning. He himself observed the aurora for an hour until its gradual return to its first appearance, the dying out of its beams and the drifting of the luminous remnants of the arches gave him the idea that the display was nearing its end. A friend of his, however, kept up the watch for a second hour, and reports that the various stages described above repeated themselves after various intervals, and that some of the luminous clouds drifted as high as the zenith. How long the display lasted is not known, but the next morning at five o'clock the sky was completely overcast and there was no sign of an aurora.

On the following night there was another display of the aurora. It was noticed as early as 7:15 P.M., about an hour after sunset. The sky was not as transparent as on the preceding night, because the wind had been from the south all day. The arch was about the same, except that it had shifted bodily 20 degrees to the east. There were a few streamers of various lengths, but they died out quickly. Clouds began to form, and by 9:30 the whole sky was obscured. The aurora could, however, be seen to some extent through the clouds, and appeared like the lights of a distant city reflected from the clouds. It was still visible after ten o'clock. But there was no sign of it the next morning nor on the following night, although the sky was perfectly clear.

William Francis Rigge
Creighton University Observatory,
Omaha, Nebr.

QUOTATIONS

STATE SUPPORT OF MEDICAL EDUCATION

The wave of reform in medical education moves steadily on, and of much significance is the part which state universities are taking in this reform. Slowly but surely colleges organized and conducted on the stock corporation basis are either obtaining connection with privately endowed universities or are giving way to the state supported university medical school. In the latter instance, the medical school is conducted as an integral part of the state's educational system. The latest instance is in Arkansas, where two independent medical schools, the College of Physicians and Surgeons and the University of Arkansas medical department, both of Little Rock, have been united. The school formed by this consolidation is to be controlled and financed by the University of Arkansas. This is but a repetition of what has already taken place in Indiana, Minnesota, Colorado, and the other states, where only one medical school remains in each instance, that being the medical department of the state university. In several other states, generous appropriations have been made for state university medical schools. This larger state support of medical education has another significance, however. It means that since the state is endeavoring to provide a good training for medical students it will not tolerate the turning out of poorly trained doctors by low-grade institutions. In fact, the inferior medical colleges even now are reading the handwriting on the wall. This accounts for the opposition, direct

or indirect, which they are making toward state endowments for medical education in Nebraska, Illinois and elsewhere. This opposition, however, will not be misunderstood and the progress for better standards of medical education has received too much impetus to be stopped by obstructions prompted by selfish interests. It is not only the right, but also the duty, of each state to provide a good training for those who are to have in charge the health of the people of that commonwealth as is the case in nearly all other countries.—*Journal of the American Medical Association.*

SCIENTIFIC BOOKS

Some Neglected Factors in Evolution. An Essay in Constructive Biology. By HENRY M. BERNARD, edited by MATILDA BERNARD. New York and London, G. P. Putnam's Sons. 1911.

The late Mr. H. M. Bernard has written several works which testify to a painstaking industry and a desire to take a broad view of the problems which arose in connection with his line of work. His more important contributions to zoology were volumes on the Apodidæ, the "Catalogue of the Madreporarian Corals in the British Museum" and his studies on the retina, and it was these last, especially, that were responsible for the ideas expressed in the volume under review, which has been edited from unpublished manuscripts by Mrs. Bernard. Bernard's studies of the retina led him to regard it as a syncytial network, and this conception rendered him skeptical as to the cell as the ultimate structural unit; it seemed to him to demand the postulation of a simpler unit, which might stand in the same relation to the cell as this does to a metazoan. This unit he termed a chromidium and described it as a particle of chromatin from which delicate linin filaments radiate, the stellate linin-chromatin mass being "embedded in a minute drop of some fluid albuminous matrix to the surface of which the filaments extend." By the growth and frequent partial division of such a unit a cell is formed, a unit of a higher grade and capable of being regarded as a synchromidium in which the chromatin material has become aggregated mainly at the center of the mass, the linin-filaments of the various component chromidia uniting to form a network and felting together to form the nuclear membrane. By this conception of the cell the author imagined that he had succeeded in reconciling two very divergent theories of cell structure, the chromatin particles being identical with Altmann's granules, while the linin-network produces the appearance which Bütschli had attributed to a foam structure. Just as the chromidium by imperfect division gives rise to the cell person represented by the protozoa, so this gives rise to individuals of a higher grade, the gastræal unit, represented by the cœlentera and the platyhelminths, and this to an annelidan unit, represented by the remaining groups of animals with the exception of man, who constitutes the final grade. And throughout each of these units there is continuity of structure, the linin-filaments forming a continuum throughout the entire organism to whatever grade it may belong, and the chromatin aggregating at the nodes of the linin-reticulum to form nuclei. Special condensations of the linin-filaments occur to form such structures as the cœlenterate mesoglœa and basement membranes in general, on the surface of which the nuclear nodes arrange themselves to form epithelia. Skeletal structures, from the radiolarian shell, the sponge spicule and the cœlenterate corallum to the vertebrate supportive tissues, also form in connection with it, and it gives rise to such structures as the nematocysts, cilia and nerve- and muscle-fibers.

This is, in brief, a statement of the first of the two main theses which the book seeks to establish. It is, however, difficult to perceive the necessity for such a unit as the chromidium. It stands in quite a different plane than the other infracellular units, such as biophores, gemmules, etc., that have from time to time been suggested, in that it is an independent unit of such a great complexity that the distinction between it and a cell, except

as regards volume, is by no means clear. Furthermore, it stands on a different plane from the supracellular units recognized by the author, in that these may be seen to form ontogenetically from a cell, but no one has yet observed the ovum developing by the division of chromidia. Indeed, one of the most obvious criticisms of Bernard's book is that it shows throughout a remarkable disregard of the facts of ontogenesis and histogenesis, so much so that it sometimes describes processes as its author supposed them to occur according to his theory, rather than as they actually occur. Further the same disregard has led the author to phylogenetic conclusions which, if they are to be regarded as essential conclusions from the theory under exposition, can only serve to render the reader skeptical as to its sanity. For instance, one is surprised to find that the Alcyonaria form a phylum altogether distinct from the other Anthozoa and related to the platyhelminths, that ctenophores are medusæ with the margins of the bell fused together, that *Sagitta* represents most accurately the primitive annelid and that the leeches may be regarded as representing the invertebrate types from which the vertebrate phylum has arisen!

Much more suggestive than the first is the second main thesis of the work, namely, that there has been a rhythm in evolution, each heightening of which corresponded with the appearance of one of the recognized grades of personality, that is to say, with the establishment of colony-formation of a higher grade. The differentiation and adaption possible for a cell-person is limited, but with the establishment of cell-colonies the potentialities become greatly increased. The author's treatment of this part of his subject is however again marred by a tendency to transcendentalism. Throughout all his grades of personality he finds continuity of structure combined with colony formation, and this theory demands continuity also in the colonies formed by his highest grade of persons, mankind. It is the linin-filaments that serve for the continuity; they are conducting paths for stimuli. But after all it is the stimulus that is the important item and not the material basis of transmission, and in human colonies we find transmission of stimuli without material continuity (telepathy), so that they too fall into line with the theoretical demands. This is much like eliminating the Cheshire cat and leaving only the grin, and why ant-colonies by the same process of reasoning should not be placed with man in the highest grade of persons, it is difficult to understand.

The book is interesting as a study in speculation, but it is doubtful if the speculations will find acceptance at the hands of biologists.

J. P. McM.

The Silva of California. By WILLIS LINN JEPSON. Memoirs of the University of California, Vol. II. Berkeley, 1910.

This magnificent folio volume does credit to the author and to the university which issues such a sumptuous account of the trees of California. It comprises 283 pages of text with 11 figures, 85 full page plates, 3 folded maps, subject and geographic indexes.

After a short preface, the author considers the geographic distribution of California trees, dividing the state into a number of provinces enumerated below. The Sacramento and the San Joaquin valleys form one province, which are essentially treeless, except for five stands or groves of the valley oak, or the interior live oak, while the banks of streams are lined with willows and cotton woods. The south coast ranges with an average height of 2,000–5,000 feet, are forested near the ocean with redwood, Douglas fir, tan oak, madroña and inland with other species, such as live and blue oaks, while Monterey pine and cypress are confined to an isolated arboreal island, constituting the Monterey peninsula. The north coast ranges are considered as to their climatic and floristic aspects with the redwood most prominent and the Douglas fir, tan oak, lowland fir, coast hemlock, Sitka spruce of secondary importance. The forest flora of the Sierra Nevada Mountains is enumerated, as well as that of

southern California, and the following zones are recognized, according to the classification of C. Hart Merriam: Sonoran, Transition, Canadian, Hudsonian and Boreal. A useful census of California trees is given where the species are not only arranged according to families, but the occurrence of each in the several previously mentioned phyto-geographic provinces is given. Jepson recognizes the difficulty of always deciding as to whether a species is a tree or a shrub by a brief account of the arboreous forms of shrubs, such as *Prunus demissa, Alnus tenuifolia,* toyon *Heteromeles arbutifolia,* etc. A list of the typically Californian species is added. Perhaps to the ecologist, the most interesting part of the memoir is the one devoted to the dendrologic characters of California trees. These are considered under the captions, mutilation and regeneration, seed production, architectural forms, wind-controlled tree forms, weeping trees, vanism in endemic species, natural hybrids, the "walnut-oak hybrids," teratology, leaf persistence, age of California trees and a bibliography with consideration of nomenclature.

After a synopsis of families, the author proceeds to minutely describe the characters, botanic habitat and history of each tree found in the Californian region and these full descriptions are supplemented by the plates of trees in the forest, as well as numerous plate figures illustrating the botanic characters of each tree admitted into the volume, as occurring within the confines of the state. Two maps illustrate the geographic distribution of the big trees (*Sequoia gigantea*) and a third is a general map of California showing the mountain chains, valleys and river systems of most importance to phytogeography. To make the work completely rounded, a subject index and a geographic index conclude the memoir. Altogether in a most thorough manner, Professor Jepson leaves little for the future botanist to consider from the purely systematic standpoint. The volume ably supplements the account of the California trees given in Sargent's "Silva," in Ludworth's "Forest Trees of the Pacific Slope" and in Britton and Shafer's "North American Trees."

John W. Harshberger
University of Pennsylvania

Hawaii and its Volcanoes. By Charles H. Hitchcock, LL.D., Emeritus Professor of Geology in Dartmouth College. Pp. viii + 314; 52 plates. Honolulu, The Hawaiian Gazette Co., Ltd. 1909. Second edition, with supplement of 8 pages, 1911.

The Hawaiian Islands have long attracted the attention of vulcanologists because nowhere else in the world can basaltic volcanoes of such majestic proportions be so easily studied as to both past history and the phenomena of active eruption. While but two centers can be described as now active, there are many others where erosion has revealed details of internal structure and petrographic constitution.

It is but natural that with nearly all explorers of the islands the liveliest interest has attached to Mauna Loa and Kilauea, where the spectacular phenomena of basaltic eruptions are displayed every few years and may be observed with ease and safety. Owing to the frequency of these eruptions during the last hundred years there is quite an extensive literature recording the observations of different outbursts, by geologists or laymen.

Kilauea in particular presents such an unrivalled opportunity for the study of the working of a basaltic volcano that several writers have given much space to recording its observed changes in historic times. Dana's well-known "Characteristics of Volcanoes" devotes nearly two thirds of its space to Kilauea and Mauna Loa, giving with considerable detail the recorded history of these volcanoes. Dutton, in his Geological Survey report on the Hawaiian Islands,[1] also quotes extensively from the published records of the principal eruptions of the active volcanoes.

It is clearly desirable that the eruptive history of Kilauea and Mauna Loa should be made as complete as possible, so that the student of present and future conditions at

[1] Fourth Ann. Rept. U. S. Geol. Survey, 1882–3.

these centers may have at his disposal all recorded observations of the phenomena of earlier outbreaks or periods of quiet. During a residence of several years in Hawaii, Professor Hitchcock has sought to complete the record of the active volcanoes by search of all available sources of information and by personal study of many features. The book under review is the result of this research. Its object is said to be "to describe correctly the phenomena connected with the discharges of molten lava from the two great Hawaiian volcanoes—Kilauea and Mauna Loa." "It is presumed that all the Hawaiian volcanoes throughout the archipelago have been developed in a similar manner. . . ."

From this point of view the work is the most satisfactory source of information on the subject, because compiled with care and with the aim of completeness.

The work is arranged in four parts. Part I., of 55 pages, is called Physiography of the Hawaiian Archipelago. Here may be found a brief but desirable sketch of the character and relations of the reefs and low islands which stretch away for more than a thousand miles to the northwest of Niihau, the most westerly inhabited island of the main group. In this part is found, also, the entire description, physiographic and otherwise, of Kauai, Oahu, Molokai, Maui and even of Hawaii, exclusive of the active volcanoes. Considerable space, relatively, is given to the stratigraphy of the water-bearing tuffs and coraline sands and limestones in the vicinity of Honolulu, to the study of which the author has given much attention.

Parts II. and III. are devoted, respectively, to the great volcanoes of Mauna Loa and Kilauea, and consist, as above indicated, chiefly of the compiled record of exploration and observation. Valuable as this record is, it serves to emphasize the fact that up to the present time little attempt has been made to study the phenomena displayed in other than a rather superficial manner. The actual physics of basaltic magma, the gaseous emanations accompanying it, the chemical composition of special magmas exhibiting certain phenomena, and the whole vast problem of volcanic energy, have scarcely been touched by observations thus far made at these volcanoes. It is to be hoped that some plan for more thorough investigations may be carried out. The field is certainly a most promising one.

Part IV. reviews The Hawaiian Type of Volcanic Action by summarizing the phenomena observed and citing the views of various authors as to their explanation. The comparison of Lunar and Hawaiian physical features by Pickering is specially noted.

In an appendix (17 pages) are given notes on earthquakes in Hawaii, the origin of the moon, the use of the spectroscope, a table of analyses of Hawaiian lavas, and biographical notes of explorers of the islands.

The second edition presents a supplement of eight pages, containing further data on certain eruptions, a criticism of W. T. Brigham's volume "The Volcanoes of Kilauea and Mauna Loa,"[1] and a list of errata, which is by no means complete.

The illustrations of this work are chiefly half-tone reproductions of photographs, which give an excellent idea of the volcanoes and their lava forms, and valuable sketch maps of the craters at several stages of development. The book is attractively gotten up, well printed, and is a credit to the enterprise of the Honolulu newspaper house which has published it.

Whitman Cross

SPECIAL ARTICLES

THE PERMEABILITY OF LIVING CELLS TO SALTS IN PURE AND BALANCED SOLUTIONS

Overton performed experiments on *Spirogyra* and other plant cells and later upon various animal cells and came to the conclusion that only those substances penetrate which are soluble in lipoid. His criterion of penetration is simple and precise. If a solution plasmolyzes a cell and the protoplast does not subsequently expand if left in the solution it is clear that the dissolved substance does not penetrate. If it penetrated it would gradually

[1] "Memoirs of the Bernice Pauahi Bishop Museum," Honolulu, 1909.

increase the osmotic pressure inside the cell until the latter equalled the external pressure. In consequence the protoplast would expand and return to its original condition. Overton found that salts in general produce plasmolysis which is not followed by expansion of the protoplast. He therefore concluded that salts are unable to penetrate.

A repetition of Overton's experiments on *Spirogyra,* using the same criterion of penetration which he employed, has led me to the opposite conclusion. In my experiments with salts of NH_4, Cs, Rb, Na, K, Li, Mg, Ca, Sr and Al, the protoplast which is plasmolyzed and left in the solution expands again to its normal size, showing that all these salts readily penetrate the protoplasm.

I cite for illustration an experiment with NaCl for the reason that this is very generally employed as a plasmolyzing agent. Filaments of *Spirogyra* were placed in a .4M NaCl solution. Within two minutes the protoplasts of most of the cells were so far plasmolyzed that they no longer touched the end walls of the cells. Several of these were accurately sketched with the camera lucida and kept under continuous observation. In the course of ten minutes several of them had begun to expand and in thirty minutes all had expanded so as to completely fill their respective cells. To avoid the injurious action of the salt, the filaments were then transferred to .18M $CaCl_2$ solution and this was gradually diluted until its osmotic pressure was not greater than that of tap water. The cells were then transferred to tap water. They were examined the next day and found to be alive. On being placed in .4M NaCl they were plasmolyzed and afterward expanded as before.

Recovery from plasmolysis is about as rapid in KCl as in NaCl, while in $CaCl_2$ it is much slower. On the other hand, in CsCl it is much more rapid than in NaCl. In a subsequent paper the behavior in the various salts will be fully described.

Certain facts may be worthy of mention which tend to obscure these results and which may have caused them to be overlooked.

In the experiment just described the cells were transferred to a favorable solution as soon as expansion was complete. If this precaution be neglected and the cells be allowed to remain in the NaCl solution the injurious action of the salt soon causes the protoplast to shrink. In salts which are more toxic than NaCl this shrinkage may be more rapid and more pronounced. This shrinkage, which I have called false plasmolysis,[1] may also be produced by very weak (hypotonic) solutions and has nothing to do with plasmolysis but may simulate it in very misleading fashion. If the cells are not continuously observed but only examined at intervals the expansion of the protoplast may be easily overlooked, and the subsequent shrinkage may be easily mistaken for plasmolysis.

A further necessary precaution is the observation of the same individual cell during the course of the experiment. To provide for this and at the same time to keep the concentration of the solution unchanged, a variety of devices was employed which will be described elsewhere.

Cells which expand promptly if only slightly plasmolyzed may not expand at all if severely plasmolyzed.

Some kinds of *Spirogyra* are wholly unsuited for these experiments because they are quickly injured by the salts (or by distilled water made in metal stills if this be used for solutions) in such a way that they expand poorly or not at all.

Another proof of the penetration of a salt is illustrated by the action of $CaCl_2$ and NaCl. A portion of a *Spirogyra* filament was plasmolyzed in .2M $CaCl_2$ but not in .195M $CaCl_2$. A .29M NaCl solution has approximately the same osmotic pressure as a .2M $CaCl_2$ solution. But on placing another portion of the same *Spirogyra* filament in a .29M NaCl solution the expected plasmolysis does not occur and it is impossible to plasmolyze the cells until they are placed in .4M NaCl. It would appear that this difference between the behavior in $CaCl_2$ and NaCl is caused by the more rapid penetration of the latter. This supposition is in perfect accord with the con-

[1] Cf. *Bot. Gazette,* 46: 53, 1908.

clusions drawn from the rate of expansion, as stated above.

But the most striking proof possible of the penetration of the salt is afforded by the following simple experiment. By dividing a *Spirogyra* filament into several portions it was found that it was plasmolyzed in .2M $CaCl_2$ and in .38M NaCl but neither in .195M $CaCl_2$ nor in .375M NaCl. On mixing 100 c.c. .375M NaCl with 10 c.c. .195M $CaCl_2$ and placing other portions of the same filament in it, prompt and very marked plasmolysis occurred. Here we arrive at the extraordinary result that *by mixing together two solutions neither of which is able to plasmolyze we produce a solution which plasmolyzes strongly.* The experiment is so simple and striking that it is admirable for class-room demonstration.

It may be noted that in this experiment we add to a solution of NaCl a solution of $CaCl_2$ which is of much lower osmotic pressure. It is evident that although the addition of the $CaCl_2$ lowers the osmotic pressure, it nevertheless increases the plasmolyzing power of the solution considerably. Evidently it can do this by preventing the NaCl from penetrating the protoplasm or the two salts may mutually prevent each other from going in. The behavior of the cell indicates that in most cases the latter alternative is to be preferred. This will be fully discussed in another paper.

In the course of time the cells in the mixture of NaCl and $CaCl_2$ may expand, but this occurs very much more slowly than in pure NaCl. The appearance of the cell then shows in the clearest manner that it is not NaCl alone which has penetrated and caused the expansion, but rather NaCl and $CaCl_2$ together. This is evident from the fact that the effects which are characteristic of pure NaCl are entirely absent. But though they eventually penetrate they do so slowly and the effect of slow penetration is very different from that produced by sudden penetration and this may largely explain why they act as antidotes to each other.

It is evident that while the mechanism of antagonistic action may depend largely on the mutual action of the antagonistic salts in preventing each other from entering we must take into account their effect on the protoplasm within the cell as well as their effect on the plasma membrane.

Marine algæ give similar results.

The chief conclusions are as follows:

1. The usual method of determining osmotic pressure by plasmolyzing in salts of Na and K is very erroneous. Salts of Ca give more nearly the true osmotic pressure.

2. Since one substance may greatly affect the penetration of another it is unsafe to use the common method of adding a toxic to a non-toxic substance and judging the penetration of the former by the plasmolytic action of the mixture.

3. It is possible to state which salts penetrate and at what rate of speed, and also how various salts affect the permeability of the plasma membrane.

4. From these data we have a definite clue to the nature of the plasma membrane. Since all the salts studied penetrate it seems certain that the membrane can not be lipoid because these salts are not soluble in lipoid. Its behavior toward balanced solutions (together with other facts) indicates unmistakably that the membrane is proteid in nature.

5. Antagonistic salts such as NaCl and $CaCl_2$ hinder or prevent each other from entering. To such an extent is this true that by choosing solutions of NaCl and of $CaCl_2$ which are not quite strong enough to plasmolyze we produce by mixing them together a solution which plasmolyzes strongly.

The fact that these salts hinder or prevent each other from entering may explain why they act as antidotes to each other. But since they may eventually penetrate to some extent we must attach importance to their effect on the protoplasm within the cell as well as to their effect on the plasma membrane. These two effects may be very similar.

W. J. V. Osterhout

INDIANAPOLIS MEETING OF THE AMERICAN CHEMICAL SOCIETY

It has become almost monotonous to write that a meeting of the American Chemical Society was

the largest so far held, but again the Indianapolis meeting of the society has exceeded its summer record with 432 members and guests present.

The meeting was very successful, both in the matter of papers presented and social enjoyment. The hospitality of the local section knew no bounds and the members were treated to automobile rides, luncheons, smokers and concerts too numerous to be detailed. Interesting mementoes were given to each member that the Indianapolis meeting might not be forgotten. They consisted of watch fobs carrying the society insignia, steins carrying the society emblem in cobalt blue and gold, and bakelite cigar holders.

The meeting opened on Wednesday morning with general addresses by Charles Baskerville, on "The Chemistry of Anesthetics"; by W. Lash Miller, on "The Chemical Philosophy of High School Text-books," and by W. F. Hillebrand, on "The Quality of Platinum Utensils for Laboratory Purposes."

On Thursday evening a public lecture was given by A. D. Little at the German House, on "The Earning Power of Chemistry."

The banquet on Friday evening was addressed by Governor Marshall, of Indiana, and Ex-Vice-President Fairbanks and was graced by the presence of many ladies, including Mrs. Marshall.

The various manufacturing plants around Indianapolis threw open their doors to the chemists and in many instances gave special entertainment to them.

The papers presented at the meeting follow by title and by abstract so far as abstracts have been procured.

Charles L. Parsons,
Secretary

Chemistry of Anesthetics: Charles Baskerville, Ph.D., F.C.S., professor of chemistry, College City of New York. Printed above.

DIVISION OF AGRICULTURAL AND FOOD CHEMISTRY

H. E. Barnard, *chairman*

B. E. Curry, *secretary*

Composition of the Drainage Water of a Soil with and without Vegetation: T. Lyttleton Lyon and James A. Bizzell.

Drainage water was collected from twelve large tanks, a description of which has previously been published. Each tank is slightly over four feet square and four feet deep with a capacity for about three and one half tons of soil. The drainage collected between May 23, 1910, and May 1, 1911, is taken as the basis for a study of the influence of vegetation on the removal of mineral matter in the drainage water.

Three tanks contained no plants, four were planted to corn and two to oats.

The nitrogen in the corn crop plus that in the drainage water from tanks cropped to corn amounted to 151 pounds per acre. That in the oat crop and drainage from the oat tanks amounted to 103 pounds per acre. There were, therefore, 48 pounds per acre more available nitrogen in the corn soil than in the oat soil. This is in line with the results of previous work by the writers, which indicated either that the corn plant has a stimulating effect on the process of nitrification, or that it utilizes to a large extent nitrogen in forms other than nitrates, or that both of these phenomena occur.

The bicarbonates were large in amount, but the much greater loss of basic material from the uncropped than from the cropped soil was removed mainly in the form of nitrate and not as bicarbonate. Any system of soil management which results in a decreased removal of nitrates in the drainage water will probably effect a conservation of bases in the soil.

The Influence of the Reaction of Solution on the Development of Wheat Seedlings: J. F. Breazeale and J. A. LeClerc.

Cold Storage and the Cryabiotic Point: W. D. Richardson.

It is proposed to call the temperature below which the growth and reproduction of the lower microorganisms is prevented by the solid condition of the medium the "cryabiotic point," the derivation being obvious. The growth and reproduction of microorganisms implies increase in size, and such a growth is effectually resisted by such a solid medium as ice. The cryabiotic point for water would, therefore, be its freezing point 0° C. For media containing common salt, in which media bacteria thrive at temperatures much below 0° C., the cryabiotic point would be the cryohydric point of salt and water, or minus 22° C. For butter the cryabiotic point would also be approximately the cryohydric point of salt and water, or minus 22° C. For meats the cryabiotic point would be the temperature at which enough water had frozen out in the pure state to leave a solution so concentrated as to be a solid in the ordinary sense of the word.

In the past and current discussions on cold storage there has been much confusion owing to a failure to distinguish between temperatures used

for the storage of foods in which the foodstuffs were not solidly frozen, and hence in which bacterial activities were not absolutely stopped, although they may have been retarded, and those temperatures in which the foodstuffs were frozen so solidly that bacterial growth and reproduction became impossible. It is believed that the introduction of the expression "the cryabiotic point" will serve to distinguish between the two cases in discussions on the subject of cold storage.

The Composition of Canned Tomatoes: E. H. S. BAILEY and H. L. JACKSON.

The authors have made some examinations of quite a large number of brands of canned tomatoes on the market, especially with reference to the amount of solids in proportion to the juice. The solids in the juice are also determined as well as the ash. Some methods of standardizing canned tomatoes, by a determination of the solids and the ash are also discussed.

The Chemical Changes which take place during the Spoilage of Tomatoes, with Methods for Detecting this Spoilage in Tomato Products: R. F. BACON and P. B. DUNBAR.

Two New Pieces of Apparatus; (a) Apparatus for the Continuous Extraction of Liquids with Immiscible Solvents Lighter than Water, (b) A Compact Apparatus for Quantitative Determinations based on the Measurement of an Evolved Gas: R. F. BACON and P. B. DUNBAR.

The Action of Non-acid Foods on Tin Containers with Special Reference to Canned Shrimp: R. F. BACON and W. D. BIGELOW.

Determination of Tin in Food Products: EDWARD GUDEMAN.

A Chemical Study of Certain "Sandhill" Soils of South Carolina: T. E. KEITT.

The Volatile Acids of Corn Silage: ARTHUR W. DOX and R. E. NEIDIG.

The Arsenic Content of Shellac and the Arsenical Contamination of Food Products from that Source: H. B. SMITH.

The Solubility of CaO in Contact with Clay: B. E. CURRY.

Clay, known as fuller's earth, was kept in contact with water until equilibrium was established. From the solubility of the CaO it has been determined that the lime and clay form two series of solid solutions, the first extending from 0 per cent. to about 3 per cent. CaO and the second extending over a range from about 25 per cent. to 45 per cent. CaO.

A Short Method for the Determination of Soluble Arsenic in Commercial Lead Arsenates: T. O. SMITH and B. E. CURRY.

A 2-gram sample of lead arsenate is stirred continuously for 18 hours with 500 c.c. of water. When a correction is made for the solubility of lead arsenate the results are comparable to those obtained by the A. O. A. C. method in 10 days. When 500 c.c. of water is used the addition of 46 per cent. to the results give the same value obtained by the A. O. A. C. method.

By making a small correction for the solubility of lead arsenate the amount of soluble arsenic not combined with lead is obtained. The results obtained by the A. O. A. C. method include a large amount of arsenic combined with lead.

Methods of Estimating Fats in Tissue: W. KOCH.

For purposes of biological interpretation of analytical results it is necessary to distinguish between neutral fats and combined fats or lipoids. None of the present methods of estimating fat, including the official method, permit of this. The method of indirect estimation suggested by Koch and Carr obviates this difficulty. Further data on the comparison of this method with others were given and will be published in detail later.

It may be stated, however, that the Kumagawa and Suto method gives results which are below the actual quantity of total fatty acid on account of incomplete saponification of combined fats, especially in such tissues as liver and brain. The Koch and Carr method gives results which on account of certain sources of error, that it has not yet been possible to eliminate, gives results which are probably somewhat too high.

The Distribution of Organic Constituents in Soils: OSWALD SCHREINER and ELBERT C. LATHROP.

Dihydroxystearic Acid in Good and Poor Soils: OSWALD SCHREINER and ELBERT C. LATHROP.

Studies on Organic Soil Nitrogen: ELBERT C. LATHROP and BAILEY E. BROWN.

The Effect of Phosphorus Manuring on the Amount of Inorganic Phosphorus in Flat Turnip Roots: BURT L. HARTWELL and FREDERICK S. HAMMETT.

As a result of chemical and microscopical examinations of flat turnip roots the percentage of inorganic phosphorus seems to be influenced more than that of the total phosphorus, by the amount of available phosphorus in soils; and that its determination therefore in the turnips is likely to be more useful for securing indications of the

relative phosphorus deficiencies in soils than the determination of total phosphorus which had heretofore been made use of at that station in ascertaining the relative phosphatic requirements.

Composition of the Timothy Plant at Different Stages of Growth: L. D. Haigh and P. F. Trowbridge.

The following table shows the per cents. of plant food constituents on the dry basis in the timothy plant at different stages. The per cent. of moisture is highest in the young timothy plant and shows a steadily declining value up to full ripening.

	Before Heading Out	After Heading Out	Blossoming	Ripe
Protein ($N \times 6.25$)	6.87	5.39	4.53	4.80
Ether soluble (fat)	3.13	3.00	1.89	2.20
Crude fiber	26.69	28.28	38.10	27.43
Ash	7.50	6.30	5.24	4.58
Nitrogen free extract	55.80	57.03	58.24	61.00

The plant food constituents other than carbohydrates have their highest percentage value before the head forms, as these are taken up most rapidly at this time. After heading out the carbohydrates are formed more rapidly, so that the percentage values of the other constituents decrease even while they are still being taken up.

The timothy plant, as a whole, takes up large amounts of nitrogen and mineral matter in the young stages but the amounts at any stage become less as ripening approaches. Nitrogen-free extract is formed at an increasing rate as the plant ripens.

The heads of the timothy increase in all its constituents during growth and ripening. As the seed ripens, a large increase of phosphoric anhydride occurs. This increase is not at the expense of some other part, but a distinct addition from the soil. From blossoming to the nearly ripe condition the phosphoric anhydride increases from 27.01 to 50.17 pounds per acre in the total plant.

The stalks increase in amount of total dry matter during growth and ripening, but a decrease occurs in the amount of nitrogen and ether soluble material during ripening. This is due, partly to dead leaves falling from the stem, and partly to transference of this material to the heads.

The bulbs increase in dry matter during growth, the amount then remains constant during ripening. The principal constituents added are nitrogenous matter and nitrogen-free extract, but no starch is formed in the bulbs at any stage. The potassium oxide and phosphoric anhydride remain about constant in amount from the time of heading to full ripening.

A large amount of potassium oxide especially is required for the growth of the timothy plant. One ton of air-dry timothy hay cut when nearly ripe will remove twenty-five pounds of potassium oxide and sixteen pounds of phosphoric anhydride from the soil.

The Detection and Determination of Small Quantities of Ethyl Alcohol, Methyl Alcohol and Formic Acid: R. F. Bacon.

The Determination of Malic Acid: P. B. Dunbar and R. F. Bacon.

The Detection of Benzoic Acid in Coffee Extract: Hermann C. Lythgoe and Clarence E. Marsh.

Coffee extract contains a substance which will give a reaction for benzoic acid. Acidify the sample, extract with ether, extract the ether with ammonia and evaporate the ammoniacal solution to a small volume and add manganese sulphate which will remove the disturbing substance. Filter, add ferric chloride and in the presence of benzoic acid a dark greenish precipitate occurs. Evaporate to dryness, sublime, take the melting point of some of the crystals and prepare the ammonium salt with the rest which will give the characteristic precipitate with ferric chloride if benzoic acid is present.

The Composition of Tincture of Ginger: H. C. Lythgoe and L. I. Nurenberg.

Several tinctures were made from Jamaica, African, Cochin and oleoresin gingers using alcohol of varying strength (approximately 95 per cent., 75 per cent., 50 per cent. and 25 per cent.), with the view of ascertaining the influence upon the composition. It was found that alcohol of 70 per cent. or more, especially in the case of Jamaica ginger, gave approximately the same amount of alcohol-soluble solids. The total and water-soluble solids increase as the strength of alcohol used decreases, and when the latter goes below 70 per cent. the alcohol soluble solids decrease. Of the tinctures made from oleoresin ginger, the one made from 95 per cent. alcohol was the only one which showed any appreciable amount of ginger resins.

The Volatile Acidity of Tragacanth and other Gums: W. O. Emery.

Akron (Ohio) Water: Home Treatment for Bath and Laundry: Charles P. Fox.

(*To be continued*)

SCIENCE

FRIDAY, AUGUST 18, 1911

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES

THE universities of the United States have this year conferred the degree of doctor of philosophy[1] on 437 candidates, a considerable increase over the number in any preceding year. In the ten-year period from 1898 to 1907 the average number was 272.4, in the four last years the numbers have been 378, 389, 358 and 437. About 50 Americans receive annually the degree of doctor of philosophy or its equivalent abroad, and about three fourths of those who carry forward scientific research hold the degree. The writer has compiled data, not yet published, which show that about three fourths of those who receive the doctor's degree in science continue to do scientific work. From these figures it appears that about four hundred a year are added to those engaged in scientific and scholarly work. This is a small number compared with those who enter other professions, but it is at all events gratifying that it has about doubled since the publication of

[1] Including two doctorates of science, one at Harvard and one at New York, and two doctorates of engineering, one at the Massachusetts Institute and one at the Ohio State. The latter degree may be desirable, the former is not. When 239 degrees are given in the natural and exact sciences it is rather absurd to call 237 of them doctorates of philosophy and two doctorates of science. At Harvard the doctorate of philosophy does not mean that the candidate has studied Latin in the secondary school, but the doctorate of science means that he has not. In the interests of consistency the degree of master of science was established several years ago at Harvard, but it was soon abandoned. The doctorate of science should be permitted to follow it.

these statistics was begun fourteen years ago.

The 75 degrees from Columbia is the largest number hitherto conferred by any American institution and places this university first in the total number of doctorates given in the past fourteen years. Chicago follows closely, with 545 degrees, 10 fewer than Columbia, and is followed by Harvard, Yale, Johns Hopkins, Pennsylvania and Cornell, the decrease being in each case in the neighborhood of fifty degrees. These seven universities are responsible for about three fourths of the degrees conferred. Among state universities, Wisconsin and Illinois have maintained the position which they have recently acquired, having granted this year, respectively, 15 and 11 degrees, as compared with six from Michigan and the same number from California. During the ten-year period beginning in 1898, Chicago, Harvard, Columbia, Yale and Johns Hopkins conferred nearly the same number of degrees, varying from 356 at Chicago to 305 at the Johns Hopkins. In the course of the past four years Columbia has taken a decided lead, while Cornell and Pennsylvania have passed the Johns Hopkins and approach Yale. The figures are: Columbia, 233; Chicago, 189; Harvard, 157; Yale, 134; Cornell, 125; Pennsylvania, 116; Johns Hopkins, 106. The standards maintained by these universities are not the same. The percentages of the doctors who took their degrees prior to 1906 in the natural and exact sciences attaining the standard of scientific recognition indicated by the asterisks in the "Biographical Directory of American Men of Science" are: Harvard, 37; Johns Hopkins, 34; Chicago, 27; Cornell, 22; Columbia, 20; Yale, 19; Pennsylvania, 8. It should, however, be noted that the superior records of Harvard and the Johns Hopkins are in part due to the fact that they gave a relatively larger number of degrees at an earlier period.[2]

The number of doctorates conferred in the natural and exact sciences is increasing more rapidly than in other subjects. Prior to 1908 the average number of degrees conferred in the sciences was 124, as compared with 148 in the other group; in the three following years the average numbers were 186 and 189, respectively; this year the numbers were 239 and 198. As shown in Table II., Chicago is the university which has conferred the largest number of degrees in the natural and exact sciences, followed by the Johns Hopkins and Columbia. Of the degrees conferred at Cornell, 64 per cent. have been in the sciences, at the Johns Hopkins 58 per

[2] The report of the commissioner of education gives annually the number of doctorates of philosophy conferred by American universities, and as it is printed later than the report in SCIENCE it might be assumed to be more complete and accurate. This, however, appears not to be the case. In the report for 1910 St. Louis University is reported as giving 17 doctorates of philosophy and Grove City College 6. The degrees attributed to St. Louis University were an error, no doctorates of philosophy having been conferred. Grove City College may have had a legal right to confer this degree, but according to the same report of the commissioner of education it has no graduate students and its total endowment is $25,000. In answer to an inquiry the president of this college writes: "In reply to your esteemed favor would say, that the six doctorates to which you refer were conferred by Grove City College upon men who had previously received their bachelor degrees and who had given two years and more to the prescribed courses of study in philosophy maintained by this institution and in addition, two full summers in residence under my personal instruction, as well as that of Professor Ormond, of Princeton, and Professor John E. Clarke, of the Boston University. Some of these also had taken a course at Grove City under the late Borden P. Bowne, who assisted me in this work for some twelve or fourteen years. Any further information desired will be promptly forwarded."

TABLE I

Doctorates Conferred

	Average of 10 Yrs. 1898–1907	1908	1909	1910	1911	Total for 14 Yrs. 1898–1911
Columbia	32.2	55	59	44	75	555
Chicago	35.6	54	38	42	55	545
Harvard	33.8	42	38	35	42	495
Yale	31.8	32	44	27	31	452
Johns Hopkins	30.5	28	27	23	28	411
Pennsylvania	22.5	32	29	26	29	341
Cornell	18.1	22	34	35	34	306
Wisconsin	8.6	17	16	18	15	152
Clark	8.7	11	9	14	16	137
New York	6.7	15	13	11	17	123
Michigan	6.9	4	13	7	6	99
Boston	4.4	11	13	6	13	87
California	3.3	4	10	6	6	59
Princeton	2.6	6	4	8	9	53
George Washington	2.8	3	4	4	5	44
Virginia	2.8	4	1	4	2	39
Bryn Mawr	2.1	4	2	5	5	37
Illinois	.5	5	4	12	11	37
Minnesota	2.4	3	5	1	2	35
Brown	2.3	2	5	1	4	35
Catholic	2.0	1	3	3	5	32
Stanford	1.4	2	3	5	4	28
Nebraska	2.0	2	2	1	0	25
Iowa	1.1	2	0	4	3	20
Cincinnati	.3	0	2	2	5	12
Massachusetts Inst.	.3	3	0	3	2	11
Missouri	.4	3	0	2	2	11
Georgetown	1.0	0	0	0	0	10
Vanderbilt	.6	1	1	2	0	10
Washington	.7	1	0	0	2	10
Indiana	.0	3	3	0	2	8
Ohio	.4	0	2	0	2	8
Pittsburgh	.1	4	0	2	1	8
Kansas	.3	0	0	3	1	7
Syracuse	.2	0	2	1	2	7
Colorado	.5	0	1	0	0	6
North Carolina	.5	0	1	0	0	6
Northwestern	.4	0	1	0	1	6
Tufts	.5	0	0	1	0	6
Washington and Lee	.4	1	0	0	0	5
Lafayette	.3	0	0	0	0	3
Dartmouth	.1	1	0	0	0	2
Lehigh	.2	0	0	0	0	2
Tulane	.1	0	0	0	0	1
Total	272.4	378	389	358	437	4,286

cent., at Harvard 40 per cent., at Columbia 37 per cent. It is somewhat curious that the percentages at Wisconsin, Michigan, Illinois and Minnesota, should be as small as 42, 39, 54 and 37, respectively, as it is the general impression that the sciences are especially emphasized at the state universities.

There were this year 65 degrees in chemistry, a larger number than had previously been conferred in any subject. It should, however, be remembered that chemistry is pursued like medicine as a preparation for professional work, and that a large percentage of those who take the doctor's degree in this science do not publish research work. The 37 degrees conferred in physics was the largest number that has been

TABLE II

Doctorates Conferred in the Sciences

	Average of 10 Years 1898–1907	1908	1909	1910	1911	Total for 14 Years 1898–1911	Per Cent.
Chicago	16.4	37	20	24	35	280	51
John Hopkins	16.8	17	20	15	19	239	58
Columbia	13.4	21	23	11	29	218	39
Harvard	14.1	13	14	10	20	198	40
Cornell	10.4	15	24	27	27	197	64
Yale	12.4	16	27	12	15	194	43
Pennsylvania	9.0	18	13	12	10	143	42
Clark	7.7	11	8	14	16	126	91
Wisconsin	2.8	6	·4	13	13	64	42
California	2.4	2	6	4	5	41	70
Michigan	2.8	1	5	1	3	38	39
George Washington	1.7	2	2	3	4	28	64
Princeton	1.1	3	3	2	5	24	45
Brown	1.2	2	2	1	3	20	59
Illinois	.3	0	2	9	6	20	54
Stanford	1.1	2	2	1	4	20	71
Nebraska	1.3	1	2	1	0	17	68
Bryn Mawr	1.0	1	0	2	1	14	38
Virginia	1.1	2	0	1	1	15	39
Minnesota	.7	1	2	1	2	13	37
New York	.6	1	3	2	1	13	11
Massachusetts Inst.	.3	3	0	3	2	11	100
Iowa	.7	0	0	2	1	10	50
Washington	.7	1	0	0	2	10	100
Missouri	.3	2	0	2	2	9	82
Catholic	.5	—	2	0	1	8	25
Indiana	.0	3	3	0	2	8	100
Ohio	.4	0	2	0	2	8	100
Cincinnati	.1	0	1	1	4	7	58
Kansas	.3	0	0	3	1	7	100
Tufts	.5	0	0	0	0	5	83
Vanderbilt	.3	1	1	0	0	5	50
North Carolina	.3	0	1	0	0	4	67
Northwestern	.2	0	1	0	1	4	67
Washington and Lee	.3	1	0	0	0	4	80
Syracuse	.1	0	0	1	1	3	43
Boston	.1	0	1	0	0	2	2
Colorado	.2	0	0	0	0	2	33
Dartmouth	.1	1	0	0	0	2	100
Lehigh	.2	0	0	0	0	2	100
Pittsburgh	—	—	—	1	1	2	25
Georgetown	.1	0	0	0	0	1	10
Lafayette	.1	0	0	0	0	1	33
Total	124.1	184	194	179	239	2,037	48

TABLE III

Doctorates Distributed According to Subjects

	Average 10 Years 1898–1907	1908	1909	1910	1911	Total for 14 Years 1898–1911
Chemistry	32.3	54	43	48	65	533
Physics	15.5	22	25	25	37	264
Zoology	15.2	25	18	24	25	244
Psychology	13.5	23	21	20	23	222
Mathematics	12.1	23	14	23	25	206
Botany	12.6	11	16	10	20	183
Geology	7.1	5	13	10	15	114
Physiology	4.1	7	13	4	2	67
Astronomy	3.4	1	7	3	4	49
Agriculture	1.0	2	7	4	11	34
Bacteriology	1.4	1	5	1	4	25
Anthropology	1.0	4	4	2	2	22
Paleontology	1.6	1	0	2	0	19
Anatomy	.9	2	0	1	1	13
Pathology	.5	2	3	1	1	12
Engineering	.8	0	0	1	2	11
Mineralogy	.6	0	3	0	1	10
Metallurgy	.3	0	1	0	0	4
Geography	.1	1	1	0	1	4
Meteorology	.1	0	0	0	0	1
Total	124.1	184	194	179	239	2,037

	1908	1909	1910	1911	Total for 4 Years
English	30	27	31	33	121
History	32	22	25	26	105
Philosophy	25	14	19	26	84
Economics	17	42	7	16	82
German	14	14	16	7	51
Education	6	9	13	23	51
Latin	12	12	15	11	50
Romance	12	16	6	12	46
Sociology	6	6	14	18	44
Oriental	9	15	11	1	36
Greek	13	11	5	7	36
Political Science	9	4	9	6	28
Theology	7	2	1	7	17
Philology and Comparative Literature	0	1	5	1	7
Law	1	0	1	2	4
Music	1	0	1	1	3
Classical Archeology	0	0	0	1	1
Total	194	195	179	198	766

conferred in any science except chemistry. In the total number of degrees conferred, chemistry and physics are followed by zoology, psychology, mathematics, botany and geology. There were 33 degrees conferred in English, 26 in history and in philosophy, and 23 in education. The degrees conferred in foreign languages appear to be few in comparison with the number of teachers required in these subjects —11 in Latin, 7 in Greek, 12 in Romance languages and 7 in German.

The institutions which this year conferred two or more degrees in a science are: in *chemistry,* Johns Hopkins, 11; Harvard, 9; Chicago and Yale, 8 each; Columbia, 6; Cornell, 5; Wisconsin, 4; Brown, 3; Clark and Illinois, 2 each; in *physics,* Chicago, 6; Columbia, 5; Pennsylvania, Stanford and Wisconsin, 3 each; Clark, Cornell, Harvard, Johns Hopkins and Princeton, 2 each; in *zoology,* Columbia, Cornell and Harvard, 4 each; Chicago, Cincinnati, Clark and Indiana, 2 each; in *psychology,* Clark, 7;[3] Chicago, 6; Columbia, 4; Pennsylvania, 3; in *mathematics,* Yale, 5; Chicago, 4; Clark, Johns Hopkins, Pennsylvania and Princeton, 2 each; in *botany,* Chicago and Cornell, 4 each; Columbia, 3; Harvard and Johns Hopkins, 2 each; in *geology,* Wisconsin, 4; Columbia, 3; Chicago, Cornell, Harvard and Johns Hopkins, 2 each; in *agriculture,* Cornell, 6; Missouri, 2.

The names of those on whom the degree was conferred in the natural and exact sciences, with the subjects of their theses, are as follows:

UNIVERSITY OF CHICAGO

Henry Foster Adams: "Some Problems of Autokinetic Sensations."

Charles Orval Appleman: "Some Observations on Catalase."

Richard Philip Baker: "The Problem of the Angle-bisectors."

Jasper Converse Barnes: "Experimental Analysis of Voluntary Movement."

George William Bartelmez: "The Bilaterality of the Pigeon's Egg; A Study in Egg Organization."

William Hunt Bates: "An Application of Sym-

[3] At Clark education appears to be included under psychology, and in some other cases the thesis in psychology is not based on experimental work.

bolic Methods to the Treatment of Mean Curvatures in Hyper-space."

Louis Begeman: "The Determination of 'e' by the Cloud Method."

Edwin Sherwood Bishop: "A Determination of the Minimum Ionizing Kinetic Energy of an Electron in a Gas."

Daniel Buchanan: "A Class of Periodic Solutions of the Problem of Three Bodies, Two of Equal Mass, the Third moving on a Straight Line."

Emma Perry Carr: "The Aliphatic Imidoesters."

Ethel Mary Chamberlain: "Purkinje Phenomenon."

Elbert Edwin Chandler: "Ionization Constants of the Second Hydrogen Ion of Dibasic Acids."

Grace Miriam Charles: "The Anatomy of the Sporeling of Marattia Alata."

J. Harry Clo: "The Effect of Temperature upon the Ionization of Gas."

William Skinner Cooper: "The Climax Forest of Isle Royale, Lake Superior."

Ira Harris Derby: "Studies in Catalysis of Imidoesters, IV."

Mabel Ruth Fernald: "A Contribution to the Technique of Diagnosis and Development of Mental Imagery."

Harvey Fletcher: "A Verification of the Theory of Brownian Movements and a Direct Determination of the Value of Ne for Gaseous Ionization."

Thomas Bruce Freas: "A Study of Thermostats."

Thomas Haigh Glenn: "Variation and Carbohydrate of Bacilli of the Proteus Group."

Mary Holmes Stevens Hayes: "Cutaneous After-sensations."

Allen David Hole: "The Pleistocene Geology of the Telluride (Colo.) Quadrangle."

Ansel Alphonso Knowlton: "Preparation and Testing of Heusler Alloys."

Stewart Joseph Lloyd: "Studies in Radioactivity."

Paul Stilwell McKibben: "The Nervous Terminalis in Urodele Amphibia."

John Colin Moore: "The Action of Water on Acyl Isoureas."

William Cabler Moore: "Studies in Organic Amalgams."

Robert Kirkland Nabours: "Mendelian Inheritance in Orthoptera."

Arthur Dunn Pitcher: "The Interrelations of Eight Fundamental Properties of Classes of Functions."

John Littlefield Tilton: "The Pleistocene Deposits of Warren County, Iowa."

Fred Wilbert Upson: "On the Action of Normal Barium Hydroxide on d. Glucose and d. Galactose."

Clara Jean Weidensall: "Studies in Rhythm."

Marion Ballantyne White: "The Dependence of the Focal Point on Curvature in Space Problems of the Calculus of Variations."

James Remus Wright: "Photo-electric Effects of Metals as a Function of the Wave-length of the Incident Light."

Mary Sophie Young: "Morphology of the Podocarpineæ."

COLUMBIA UNIVERSITY

Le Roy Abrams: "A Phyto-geographical and Taxonomic Study of the Southern California Trees and Shrubs."

George Denton Beal: "Stilbazoles and Schiff Bases in the 4-quinazolone Group."

Ralph Curtiss Benedict: "The Genera of the Fern Tribe Vittarieæ."

Frederick Gordon Bonser: "The Reasoning Ability of Children of the Fourth, Fifth and Sixth School Grades."

Joseph Valentine Breitwieser: "Attention and Movement in Reaction Time."

Jessie Yereance Cann: "The Relationship existing between the Weight of a Falling Drop and the Diameter of the Tip from which it Falls."

Garabed Krikor Daghlian: "The Drop Weights of Twenty Non-associated Liquids and the Molecular Weights calculated for them."

Clarence Norman Fenner: "The Watchung Basalt and the Paragenesis of the Zeolites and other Secondary Minerals."

George Augustus Geiger: "Researches in the Quinazoline Group."

Clarence Everett Gordon: "The Geology of the Poughkeepsie Quadrangle."

Isidor Greenwald: "The Effect of Parathyroidectomy upon Metabolism."

Edmund Newton Harvey: "Studies on the Permeability of Cells."

Michael Heidelberger: "Phthalones in the Quinazolone Series and their Derivatives."

Frank Dunn Kern: "A Biologic and Taxonomic Study of the Genus Gymnosporangium."

Edwin Kirk: "The Structure and Relationships of certain Eleutherozoic Pelmatazoa."

Francis Church Lincoln: "Certain Natural Associations of Gold."

Almer McDuffie McAfee: "The Drop Weight

of the Associated Liquids—Water, Ethyl Alcohol, Methyl Alcohol and Acetic Acid."

Charles Virgin Morrill: "The Chromosomes in the Oogenesis, Fertilization and Cleavage of Coreid Hemiptera."

Paul Radin: "The Ritual and Significance of the Winnebago Medicine-lodge."

Harry Wilfred Reddick: "Systems of Tautochrones in a General Field of Force."

Gaillard Sherburne Rogers: "Geology of the Cortlandt Series and its Emery Deposits."

Frederick William Schwartz: "The Weight of a Falling Drop and the Laws of Tate. The Drop Weights and Molecular Weights of some of the Lower Esters."

Aaron Franklin Shull: "Studies in the Life Cycle of *Hydatina senta*."

Edward Kellogg Strong, Jr.: "The Relative Merit of Advertisements: a Psychological and Statistical Study."

Edgar George Thomssen: "The Weight of a Falling Drop and the Laws of Tate. The Determinations of the Molecular Weights and Critical Temperatures of Liquids by Aid of Drop Weights with an Improved Apparatus."

Chin Yu Wen: "The Effect of Organic and Inorganic 'Addition Agents' upon the Electro-deposition of Copper from Electrolytes containing Arsenic."

Mary Theodora Whitley: "An Empirical Study of certain Tests for Individual Differences."

Louis Elsberg Wise: "Para-aminobenzonitrile and its Derivatives."

Leon Elmer Woodman: "A Study of the Multiple Reflections of Short Electric Waves between two or more Reflecting Surfaces."

CORNELL UNIVERSITY

Arthur Augustus Allen: "The Red-winged Black-bird; a Study in the Ecology of a Cattail Marsh."

Alvin Casey Beal: "A Study of the Genus *Lathyrus*."

George John Bouyoucos: "Transpiration of Wheat Seedlings as affected by Soils, by Solutions of different Densities, and by various Chemical Compounds."

Paul Prentice Boyd: "On the Perspective Jonquières Involutions associated with the (2, 1) Ternary Correspondence."

Mortimer Jay Brown: "Aluminum Anodes in Liquid Ammonia Solutions of Ammonium Trinitride."

Harold Joel Conn: "A Study of Seasonal Variation among the Bacteria in Two Soil Plats of Unequal Fertility."

Oscar Diedrich von Engeln: "Phenomena associated with Glacier Drainage and Wastage."

Henry Ellsworth Ewing: "The Origin and Significance of Parasitism in the Acarina."

Hing Kwai Fung: "An Ecological Study of the American Cotton Plant with Incidental Reference to its Possible Adaptability in China."

Henry Phelps Gage: "The Radiant Efficiency of Arc Lamps."

Franklin Stewart Harris: "Studies in Soil Moisture and Fertility."

Jessie Luella King: "The Pyramid Tract and other Descending Paths in the Spinal Cord of the Sheep, and the Localization of the Motor Area in the Sheep's Brain by the Histological Method."

Lewis Knudson: "The Relation of *Aspergillus niger* and *Penicillium* sp. to Tannic Acid Fermentation."

Robert Matheson: "The Structure and Metamorphosis of the Fore-intestine of *Corydalis cornutus* L."

Edson Hoyt Nichols: "Octochlorindigo and some Derivates of the Tetrachlorphthalic Acid and Tetrachloranthranilic Acid."

Edith Marion Patch: "Homologies of the Wing Veins of the Aphididæ, Psyllidæ, Aleurodidæ and Coccidæ."

Elmer George Peterson: "The Elimination of Tubercle Bacilli."

David Shepherd Pratt: "A Study of the Phenol Sulphonic Acid Method for the Determination of Nitrates in Water."

John Lyon Rich: "Studies in the Physiography of Semi-arid Regions."

Elmer Seth Savage: "A Study of Feeding Standards for Milk Production."

Pearl Gertrude Sheldon: "The Atlantic Slope Arcas."

Louisa Stone Stevenson: "The Fluorescence of Anthracene."

John Pogue Stewart: "Factors Influencing Yield, Color, Size and Growth in Apples."

John Armor Veazey: "The Relation of Discharge Potential, Density of Kathode Ray Current and Intensity of Fluorescence in Crystals."

Errett Wallace: "The Scab Disease of the Apple."

Arthur John Wilson: "Influence of Phosphorus in Feeds on the Phosphorus Content of the Egg, and the Chemical Character of the Phosphorus Compounds."

Frederick Adolph Wolf: "The Life History and Development of some Fungi."

HARVARD UNIVERSITY

Thomas Barbour: "A Contribution to the Zoogeography of the East Indian Islands."

Frederick Barry: (1) "The Molecular Refractions of Hydrochloric Acid and of Stannic and Stannous Chlorides"; (2) "The Heats of Combustion of Homologous Hydrocarbons."

Harold Eugene Bigelow: (1) "Some Derivatives of Bromtriioddinitrobenzol and Related Compounds"; (2) "The Heat of Solution of Barium."

Walter Ray Bloor: "The Carbohydrate Esters of the Higher Fatty Acids."

Paul Whittier Carleton: "Some Derivatives of certain Quinones and Aromatic Diketones."

Emory Leon Chaffee: "A New Method of Impact Excitation of Undamped Electric Oscillations and their Analysis by Means of Braun Tube Oscillations."

Fletcher Barker Coffin: "A Revision of the Atomic Weights of Cobalt and Arsenic."

Edward Carroll Day: "The Effect of Colored Lights on Pigment Migration in the Eye of the Crayfish."

Robert Fiske Griggs: "The Development and Cytology of Rhodochytrium."

Harvey Cornelius Hayes: "An Investigation of the Errors in Cooling Curves and Methods for avoiding these Errors; also a New Form of Crucible."

George Leslie Kelley: (1) "The Constitution and Reactions of certain Halogenated Orthobenzoquinopyrocatechin Hemiethers"; (2) "The Transition Temperature of Sodium Chromate."

Frederick Henry Lahee: "A Study of Metamorphism in the Carboniferous Formation of the Narragansett Basin."

Henry Laurens: "The Reactions of Amphibians to Monochromatic Lights of Equal Intensity."

Herbert Eugene Merwin: "Mineralogical and Petrographical Researches, with special Reference to the Stability Ranges of the Alkali Feldspars."

Emile Raymond Riegel: (1) "The Quantitative Determination of Antimony by the Gutzeit Method"; (2) "The Action of Sulphur Trioxide on Carbon Tetrachloride and Silicon Tetrachloride."

Clarence Livingston Speyers: "The Compressibilities and Surface Tensions of Water and Six Hydrocarbons."

Alban Stewart: "A Botanical Survey of the Galapagos Islands."

Thorbergur Thorvaldson: (1) "A Revision of the Atomic Weight of Iron"; (2) "Methods for the Adiabatic Determination of Heats of Solution of Metals in Acids."

Edward Gaige Titus: "Monograph of the Species of *Hypera* and *Phytonomus* in America."

Samuel Everett Urner: "Certain Singularities of Point-transformations in Space of Three Dimensions."

JOHNS HOPKINS UNIVERSITY

Paul Gough Agnew: "A Study of the Current Transformer, with particular reference to Iron Loss."

Thomas Bryce Ashcraft: "Quadratic Involutions on the Plane Rational Quartic."

Clara Latimer Bacon: "The Cartesian Oval and the Elliptic Functions."

John Lattimore Carpenter: "An Investigation of Manometers, of small Bore, for Use in the Measurement of Osmotic Pressure."

Gentry Cash: "A Study of the Osmotic Pressure of Cane Sugar Solutions at 30°, 35° and 40°."

Ernest Pohl Doetsch: "On the Rearrangement of the Tautomeric Salts of 1, 4-diphenyl-5-Thionurazole and 1, 4-diphenyl-5-Thiolurazole."

Julia Anna Gardner: "On certain Families of the Gastropoda from the Miocene and Pliocene of Virginia and North Carolina."

James Samuel Guy: "Conductivity and Viscosity in Glycerol and in Binary Mixtures of Glycerol with Ethyl Alcohol, with Methyl Alcohol and with Water."

Arthur Dunham Holmes: "A Study of the Semi-permeable Membranes of Zinc Ferrocyanide and of Copper Cobalticyanide."

Henry Hallock Hosford: "The Conductivities, Temperature Coefficients of Conductivity and Dissociation of certain Electrolytes from 0° to 35° and of certain other Electrolytes from 35° to 65°."

William Ralph Jones: "The Development of the Vascular Structure of *Dianthera Americana* L."

Nathaniel Edward Loomis: "A Study of the Hydrogen Electrode and of the Calomel Electrode."

Joseph Llewellyn McGhee: "A Study of Nickel Ferrocyanide as a Membrane in the Measurement of Osmotic Pressure."

Eli Kennerly Marshall, Jr.: "On the Reactions of Diazoalkyls with Urazoles and their Salts."

John Beaver Mertie, Jr.: "The Igneous Rocks of the Raton Mesa Region of New Mexico and Colorado."

Carroll Mason Sparrow: "On the Effect of the

Groove Form on the Distribution of Light by a Grating."

Eugene Pinckney Wightman: "A Study of the Conductivity and Dissociation of Organic Acids in Aqueous Solution between 0° and 35°."

Lula Gaines Winston: "The Conductivity, Temperature Coefficients of Conductivity and Dissociation of certain Electrolytes in Aqueous Solution, and Evidence for the Complexity of the Ion."

Harlan Harvey York: "The Origin and Development of the Embryo-sac and Embryo of *Dendrophthora opuntioides* (L.) Eich. and *D. gracile* Eich.

YALE UNIVERSITY

Harry Leslie Agard: "The Extension of some Theorems in the Theory of Sets of Points to N-dimensional Space."

Ida Barney: "Line and Surface Integrals."

Rowland Sherwood Bosworth: "The Rates of Solution of certain Metals in Dissolved Iodine, and their Relation to the Diffusion Theory."

Burton Howard Camp: "The Convergence of Singular Integrals."

Morris S. Fine: "Experimental Studies on the Utilization of Vegetable Proteins in Man and Animals."

John Lewis Jones: "Number Concept."

Carlton Howard Maryott: "On the Nature of the Reaction between Chlorine and Benzene in the Electrolytic Cell."

Claud Clair Perkins: "Molecular Silver, and its Use in the Gravimetric Determination of Iodine."

Edwin Jay Roberts: "The Separation of Cerium Earths."

William Cumming Rose: "Studies in Intermediary Metabolism: Mucic Acid and Carbohydrate Metabolism; the Physiology of Creatine and Creatinine Elimination, their Relation to Carbohydrate Metabolism."

James Cox Sanderson: "The Probable Influence of the Soil on Local Atmospheric Radioactivity."

Samuel Ray Scholes: "A Study of Vapor Pressures."

Louise Stanley: "The Occurrence of Purine Enzymes in the Tissues of Invertebrates and Lower Vertebrates."

Neil Everett Stevens: "The Meiotic Phase in Heterostylous Plants."

Wallace Alvin Wilson: "Theory of Point-aggregates applied to Lebesque Integrals."

UNIVERSITY OF WISCONSIN

William Henry Collins: "The Geology of Gowganda Mining Division."

Guy Henry Cox: "The Origin of the Lead and Zinc Ores of the Upper Mississippi Valley."

James Nimrod Currie: "A Study of the Optical Form of Lactic Acid produced by Pure Cultures *B. Bulgaricus*."

Paul Harrison Dike: "Photo-electric Potentials of Thin Cathode Films."

William Elmer Forsythe: "A Determination of the Melting Point of Tungsten and Tantalum."

Charles Baldwin Gates: "The Replacement and Solution of Metals in Non-aqueous Liquids."

Alcan Hirsch: "The Preparation and Properties of Metallic Cerium."

Arden Richard Johnson: "A Study of Organic Boro-nitrogen Compounds."

Charles Townsend Kirk: "Conditions of Mineralization of the Copper Veins at Butte, Montana."

Jesse Talbot Littleton, Jr.: "The Optical Constants of Alloys as a Function of Composition."

Frederick McAllister: "The Cytology of Convallariaceæ."

Leon Irwin Shaw: "Studies of the Conductivity of Non-aqueous Solutions."

Joseph Douglas Trueman: "The Value of certain Criteria for the Determination of the Origin of Foliated Crystalline Rocks."

CLARK UNIVERSITY

Charles Walter Bacon: "A Study of Fractional Distillation."

Guy Gaillaird Becknell: "On Demagnetization of Iron and Steel Bars by Strain and Impact."

Thomas Charles Carrigan: "The Law and the American Child."

Floyd Earle Chidester: "Cyclopia in Mammals."

Edmund Smith Conklin: "Pedagogy of College Ethics."

Herbert Carroll Cooley: "The Religious Education of Children."

Robert Hutchings Goddard: "Current Rectification at Contacts of Dissimilar Solids."

Louis Dunton Hartson: "The Psychology of the Club: A Study in Social Psychology."

McLeod Harvey: "The Pedagogy of Missions."

Solomon Lefschetz: "On the Existence of Loci with Given Singularities."

William Alderman Matheny: "Biology of *Sclerotinia fructigena* and *Sclerotinia cinerea*."

William John Montgomery: "Singularities of Twisted Quintic Curves."

Leonard Blaine Nice: "The Comparative Effects of Alcohol, Nicotine and Caffeine on the Growth and Reproduction of White Mice."

Simeon Spidle: "The Belief in Immortality."

Harry Porter Weld: "An Introspective Study of the Appreciation of Music."

Clarence Delette Wright: "A New Study of Steric Hindrance in Esterification."

UNIVERSITY OF PENNSYLVANIA

Norman Cameron: "A New Method for Determining Rate of Progress, Retardation and Elimination, as exemplified from the Records of a Small School System."

Melvin Reece Harkins: "The Transmission of Sound through Porous and Non-porous Materials."

William Brooks Hicks: "The Use of Sulphur Monochloride in the Decomposition and Analysis of Rare Earth Minerals."

John Ezra Hoyt: "Oscillographic Study of the Singing Arc."

Claude Stone McGinnis: "The Transmission of Sound through Porous and Non-porous Materials."

Norman Eugene McIdoo: "Lyriform Organs and Tactile Hairs of Araneads."

Walter Ross Marriott: "The Determination of the Order of the Groups of Isomorphisms of the Groups of Order P^4, where P is a Prime."

Louis O'Shaughnessy: "The Integrability of the Differential Equation representing the Sum of a Family of Series."

George Byron Armbruster Phillips: "Retardation in the Elementary Schools of Philadelphia."

Walter Jorgensen Young: "A Study in Practise and Habit; an Investigation into Motor Coordination, in its Relation to Attention, Association, Modification, Repetition and Habit."

UNIVERSITY OF ILLINOIS

Charles Eldrid Burke: "Molecular Rearrangements in the Camphor Series, Lauronolic Acid."

Walter Byron Gernert: "Unit Characters in Corn and their Behavior in Transmission."

George Roger LaRue: "The Genus *Proteosephalus*, Attention being given to the Morphology and Histogenesis of the Forms and to the Taxonomy of the Genus."

Duncan Arthur MacInnes: "The Physical Properties of Moderately Concentrated Aqueous Solutions of Electrolytes. (1) Salts of the Univalent Type."

William Warren Stifler: "The Magnetic Properties of Cobalt, with Especial Reference to their Interpretation on the Electron Theory and the Theory of Intrinsic Molecular Field."

Ellis Bagley Stouffer: "Invariants of Linear Differential Equations with Applications to Projective Differential Geometry."

UNIVERSITY OF CALIFORNIA

Annie Dale Biddle: "Constructive Theory of the Unicursal Plane Quartic by Synthetic Methods."

Hiram Wheeler Edwards: "The Resistance of certain Linear Conductors to Alternating Currents of High Frequency."

Joseph Eames Greaves: "Some Factors Influencing the Quantitative Determination of Gliadin."

John Alden Mason: "The Ethnology of the Salinan Indians."

Arthur Russell Moore: "On Mendelian Dominance."

PRINCETON UNIVERSITY

Robert Daniel Carmichael: "Linear Difference Equations and their Analytic Solutions."

Frederick Wahn Beal: "Associated Normal Congruences."

Otto Stuhlmann, Jr.: "The Difference in the Photoelectric Effect caused by Incident and Emergent Light."

Clinton Joseph Davisson: "Positive Thermions from Salts and Alkaline Earths."

Aute Richards: "The Method of Cell Division in the Development of the Female Sex Organs of *Moniezia*."

UNIVERSITY OF CINCINNATI

Annette Frances Braun: "Observations on the Development of Color in the Pupal Wings of Several Species of *Lithocolletis*."

Leon Denning Peaslee: "Studies on *Phagocata gracilis* (Leidy)."

Winfred Paul Webber: "On the Construction of Doubly Periodic Functions which have Singular Points (Polar and Essential) in the Period Parallelogram."

Everett Irving Yowell: "Orbit of Asteroid 1910 JR."

GEORGE WASHINGTON UNIVERSITY

George Nelson Coffey: "A Study of the Soils of the United States."

Hayner Haskell Gordon: "An Investigation of the Crystal Rectifying Delectors."

Grace Helen Kent: "Experiments on Habit Formation in Dementia Præcox."

Charles Neil McBryde: "A Bacteriological Study of Ham Souring."

LELAND STANFORD JUNIOR UNIVERSITY

Albert Edward Caswell: "Determination of Peltier Electromotive Force for several Metals by Compensation Methods."

Fred Finley Fitzgerald: "The Electrical Conductivity and Viscosity of Solutions in Methylamine and Ethylamine."

George Francis McEwen: "The Measurement of the Coefficient of Viscosity of Liquids by Means of the Forced Vibrations of a Sphere."

Perley Ason Ross: "Refractive Index of Metals."

BROWN UNIVERSITY

Moses Leverock Crossley: "Certain Derivatives of Anthraquinone of the Amido and Sulphonic Series."

Louis John Gillespie: "The Gas Metabolism of the Colon and Typhoid Bacilli."

George Barrows Obear: "The Hygrometric Properties of Gelatinous Media."

UNIVERSITY OF MICHIGAN

Floyd Earl Bartell: (1) "The Permeability of Porcelain and Copper Ferrocyanide Membranes; (2) "The Size of Pores in Porcelain and Osmotic Effects."

William Orville Mendenhall: "On the Characteristic Properties of Sum-formulæ in the Theory of Divergent Series."

Archie Garfield Worthing: "Some Thermodynamic Properties of Air and of Carbon Dioxide."

INDIANA UNIVERSITY

Max Mapes Ellis: "The Gymnotid Eels."

Will Scott: "The Fauna of a Solution Pond."

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Eugene Clarence Howe: "A Biometric Investigation of certain Non-spore-forming Intestinal Bacilli."

Reginald Lamont Jones: "The Effects of Heat and Magnetization on the Magnetic Properties of Iron."

UNIVERSITY OF MINNESOTA

Keivin Burns: "Photographic Study of the Region of the Great Nebula in Orion."

Louis Williams McKeehan: "The Terminal Velocity of Fall of Small Spheres in Air at Reduced Pressures."

UNIVERSITY OF MISSOURI

Leonard Dixon Haigh: "A Study of the Variations in Chemical Composition of the Timothy and Wheat Plants during Growth and Ripening."

Charles Robert Moulton: "A Study of the Chemical Composition of Cattle on Different Planes of Nutrition, and of the Relative Cost of Maintenance and Growth."

OHIO STATE UNIVERSITY

Lou Helen Morgan: "The Preparation and Oxidation of Styrolene Alcohol."

Cyrus Alan Melick: "An Investigation of the Stresses in Tall Steel Buildings of the Cage Construction Type with Portal Bracing."

WASHINGTON UNIVERSITY

John Jacob Kessler: "The Nitrite of Fumaric Acid."

Caroline Rumbold: "The Effect of the Acidity and Alkalinity of the Substratum on the Growth of Wood-destroying and Wood-staining Fungi, with a Discussion of the Systematic Relation of *Ceratostomella* and *Graphium*."

BRYN MAWR COLLEGE

Marie Gertrude Rand: "A Quantitative Examination of the Factors which Influence the Campimetrical Observation."

CATHOLIC UNIVERSITY OF AMERICA

Patrick Joseph Waters: "Studies in the Principle of Apperception."

UNIVERSITY OF IOWA

Charles McLean Fraser: "The Systematic Study of the Hydroids of the North Pacific Coasts of America."

UNIVERSITY OF KANSAS

Henry A. Kohman: "Salt-rising Bread."

NEW YORK UNIVERSITY

Erich Hausmann: "Electric Wave Propagation and Distortion along Conductors."

NORTHWESTERN UNIVERSITY

Eli Victor Smith: "Histology and Histogenesis of the Sensory Ganglia of Birds."

UNIVERSITY OF PITTSBURGH

Otto E. Jennings: "The Mosses of Western Pennsylvania."

SYRACUSE UNIVERSITY

Louis Lindsay: "The Minors of a Compound Determinant."

UNIVERSITY OF VIRGINIA

Charles Pollard Olivier: "175 Parabolic Orbits and other Results deduced from Observations of 6,200 Meteors."

FORECAST OF THE PORTSMOUTH MEETING OF THE BRITISH ASSOCIATION[1]

This year, for the first time in its history, the British Association for the Advancement of Science will meet at Portsmouth. There is no other town of similar size and importance in the United Kingdom which has not extended hospitality to the British Association during the fourscore years of its existence. Why Portsmouth should have remained unvisited until now it is difficult to say. The ancient centers of learning like Oxford and Cambridge and the great manufacturing centers of the midlands and the north naturally have had the principal claim on the attention of the British Parliament of Science in the course of its peripatetic career. But ports and resorts along the south coast besides Portsmouth were long ago visited by the British Association, and some have received a second visit. Plymouth was the scene of the association's annual meeting as far back as 1841, and again welcomed the association in 1877. Southampton was visited in 1846 and 1882, Brighton in 1872, and Dover in 1899.

With one exception, the experience of the British Association does not encourage hopes of a large gathering when the meeting-place is on the south coast. At the first Plymouth meeting in 1841, which began on July 20, under the presidency of the Rev. Professor W. Whewell, the attendance numbered only 891 persons; nor was the youthfulness of the association at that time the only explanation of the smallness of the number, for both at Glasgow in the previous year and at Manchester in the following year the attendance was 50 per cent. more. At the second Plymouth meeting, which opened in the middle of August, 1877, under the presidency of Professor A. Thomson, M.D., the attendance numbered 1,229 persons—considerably more than on the previous occasion, but less than half the attendance at Glasgow in 1876 and at Dublin in 1878. At the first Southampton meeting in 1846, which opened on September 10, under the presidency of Sir Roderick Murchison, the attendance was only 857, as compared with 1,079 at Cambridge in the previous year and 1,320 at Oxford in the following year. Again, at Southampton in 1882, when Dr. C. W. Siemens presided over a meeting which opened on August 23, the attendance numbered 1,253, and this meeting was sandwiched in between two of very much larger proportions, the attendance at York in 1881 being 2,557 and at Southport in 1883 being 2,714. At Dover, also, in 1899, when the association met in the middle of September, under the presidency of Sir Michael Foster, the attendance of 1,403 was very much less than the attendance at Bristol in the previous year (2,446) or at Bradford in the following year (1,915).

Brighton, however, furnishes an exception to the series of small meetings along the south coast, the strength of the meeting there in point of numbers being such that Portsmouth will do well if it attracts anything like the same attendance. The British Association met at Brighton on August 14, 1872, under the presidency of Dr. W. B. Carpenter, and the number of people registered as in attendance was returned as 2,533, a figure which compares favorably both with the attendance of 2,463 at Edinburgh in 1871 and with the attendance of 1,983 at Bradford in 1873. Of late years, quite apart from the particular place of meeting, the numbers taking part in the annual gatherings of the British Association have shown a tendency to decline. This is not surprising, seeing the way in which scientific meetings, congresses and publications, affording constant opportunity for making known the results of research work and for the discussion of those results, have multiplied. But the British Association still holds an important and unique position as the one body which affords an opportunity for intercourse and exchange of ideas between men who are interested in different branches of scientific investigation, and who in these days are more subject than ever they were to the dangers of too narrow a specialization. In providing a counteracting influence for this natural and inevitable tendency

[1] From the London *Times*.

of modern scientific inquiry, the British Association for the Advancement of Science may fulfil a function not less useful than any which it has served in the past. Those responsible for the conduct of the association's affairs have not been blind to the changing needs of the changing times, and although there is room for further modification in this direction, the efforts which have been made in the last few years, and are still being made to promote discussions among the different sections on subjects of broad and mutual interest, are deserving of all praise and encouragement. It would be a mistake to conclude from the somewhat disappointing attendances at recent British Association meetings that the association has outlived its usefulness. There is need for it to adapt its work to present-day conditions, and as and when this is done the long-hoped-for revival of interest in the annual meetings will naturally follow.

Apart from these fundamental considerations, the place and precise time of year fixed for each meeting unquestionably have much to do in determining the number participating in it, and consequently the sum of money at the disposal of the council for scientific grants. In this respect the Portsmouth meeting has much in its favor. It will open on Wednesday, August 30, and a careful analysis of the attendances at different meetings of the association held at different times of the year has shown that the meetings commencing in the last ten days of August have been among the most largely attended of any in the history of the association. Portsmouth itself has many and varied attractions, both for those who regard the week of the association's meetings as a time for the serious examination of an interesting field of study, and for those who look upon the week rather as a time of pleasant holiday, combining country excursions with brilliant social functions and the occasional hearing of instructive lectures delivered by the most eminent scientific men of the day. The history of the town extends back to the middle ages, and reveals constant and growing recognition of the advantages conferred on it by its situation, viewed from naval and strategical points of view. Ever since 1295 it has returned two members to parliament, and to-day the population of the county borough considerably exceeds 200,000. Portsmouth includes within its borders not only a great naval station and arsenal, but a popular watering-place, Southsea; and it is, as everybody knows, within easy reach both of the Isle of Wight and of the New Forest, districts which offer excellent opportunities as well for holiday jaunts as for the pursuit of field studies. The town itself is admirably equipped with educational institutions, in which the members of Section L will find much to interest them, while the dockyard presents an object-lesson in the application of modern engineering science to naval needs which will be appreciated by many besides the members of Section G. The arrangements for the meeting afford a guarantee that visitors will be able to see Portsmouth to the best advantage. Subject, of course, to the limitations imposed by the necessity of safeguarding national interests, special facilities will be afforded to the members of the British Association to view the dockyard, battleships and submarines and other government establishments.

The meeting will assemble, as usual, under the patronage of the king, Canon T. G. Bonney will be succeeded as president on the opening day by Sir William Ramsay and a very representative body of vice-presidents, including the Princess Henry of Battenberg, Alderman T. Scott Foster, the mayor of Portsmouth, Lord Winchester, Lord Lieutenant of the County of Hants, the Archbishops of Canterbury and York, and the Bishop of Winchester; Admiral Sir Arthur William Moore, the Commander-in-Chief at Portsmouth; Rear Admiral H. G. Tate, the Admiral Superintendent of the Portsmouth dockyard; Field-Marshall Earl Roberts, and Major-General J. K. Trotter, the General Officer Commanding Southern Coast Defenses. As in former years, there will be two evening discourses in addition to the presidential address. On Friday, September 1,

Dr. Leonard Hill will lecture on "The Physiology of Submarine Work," and on Monday, September 4, Professor A. C. Seward will lecture on "Links with the Past in the Plant World." The Saturday evening lecture to the operative classes will be delivered by Dr. Hugh Robert Mill. An attractive series of social functions is being arranged, including a garden party and reception, and an evening fête by the mayor of Portsmouth, and on Saturday, September 2, there will be excursions to the Isle of Wight, the New Forest, Chichester, Petworth and Arundel. On the Sunday there will be a special service at St. Mary's church, at which the Bishop of Winchester will preach.

In his presidential address Sir William Ramsay will sound as his leading note the increasing need of scientific training with a view to future as well as to present-day requirements. He will pass under review modern conceptions of the nature and constitution of the elements, especially radium and its products, and will proceed to consider the available sources of energy in this country and whether a reasonably economical use is being made of them. Having come to the conclusion that the present-day methods are wasteful, seriously limiting the period of our national existence, he will advocate an immediate stock-taking of our possessions of potential energy as the first step towards their judicious conservation.

For the following particulars of the sectional proceedings we are indebted to the courtesy of the sectional presidents and recorders.

Section A (Mathematical and Physical Science) will be presided over by Professor H. H. Turner, who proposes to consider in his opening address some of the lessons taught by the observational sciences (astronomy, meteorology, magnetism, seismology) as regards methods of work. He will emphasize the need for better organization, and will enforce his remarks by recalling recent cases which illustrate the need. A joint meeting between Section A and Section G (Engineering) has been arranged for a discussion on mechanical flight, which will be opened by Mr. A. E. Berriman, the technical editor of *Flight*. In the course of the week there will also be discussions on Stellar Distributions and Movements (to be opened by Mr. A. S. Eddington), and the Principle of Relativity (to be opened by Mr. E. Cunningham). Among the papers to be presented to the section will be one by Professor F. R. Watson, of Illinois, on the "Effect of Air Currents on Sound Waves"; Professor Pettersson will present a paper on "Great Boundary Waves," and will consider the parallactic tide set up in the bottom layers of the sea by the moon; Major E. H. Hills will have something to say on the "Infra-Red Spectrum," and Professor F. T. Tronton on the "Peculiarities in the Absorption of Salts by Silica."

Section B (Chemistry) will meet under the presidency of Professor J. Walker. The close relation between chemistry and agricultural science will be recognized in a joint meeting between Section B and Sub-section K, at which Dr. E. Frankland Armstrong will open a discussion on the part played by Enzymes in the Economy of Plants and Animals. At this meeting Mr. A. E. Humphreys will discuss the treatment of wheaten flour. Two other discussions will engage the attention of the chemists while at Portsmouth. In a discussion on Colloids, Professor Freundlich will deal with the "Theory of Colloids," Dr. G. Barger and Dr. E. Wechster with the "Absorption of Bromine by Graphite," and Dr. C. Desch with the "Colloid Theory of Cements." In another discussion on Indicators and Color, Dr. V. H. Veley will contribute a paper on the application of "Methyl Orange for the Determination of the Affinity Constants of Weak Acids and Bases," with a discussion on the Errors; Mr. H. T. Tizard will consider the "Use of Indicators in Modern Physico-Chemical Research"; Mr. J. E. Purvis, the "Absorption Spectra of Vapors"; and Dr. T. M. Lowry, the "Origin of General and of Specific Absorption." Professor G. Barus will submit to the section a paper on the "Diffusion of Gases through Water"; Professors W. H.

Perkins and W. J. Pope a paper on "Optically Active Systems containing no Asymmetric Atom," and Dr. W. Lewis a paper on the "Compressibility of Mercury." There will also be presented reports on "Electric Steel Furnaces," by Professor McWilliam, and "Solubility" by Dr. J. B. Eyre, as well as the reports of the research committees.

The president of Section C (Geology), Mr. A. Harker, proposes to deal in his presidential address with some aspects of the distribution of igneous rocks in "petrographical provinces" and the relations of these to the larger structure features of the globe. It is hoped to arrange for joint meetings with the Geographical Section, both for the consideration of the former connection between the South Coast of England and the Isle of Wight and for the consideration jointly with the Botanical Section of the plant life of the British Isles in relation to the glacial epoch.

In his presidential address to Section D (Zoology), Professor D'Arcy W. Thompson will deal with some of the new developments and problems of biology that have come into prominence during the past quarter of a century.

The debt which geography owes to the army and navy has been illustrated at several of the British Association meetings in recent years by the presence of a military or naval officer at the head of Section E. This year the geographers will meet under the presidency of Colonel C. F. Close, R.E. In the first part of his address he will discuss the purpose and position of geography, with special reference to its relations to other subjects. In order to ascertain the content of the subject, the last five years' work of the Royal Geographical Society will be examined and analyzed. The general effect of the work of geographical societies, schools and congresses will be indicated and an attempt made to determine the actual position of geography in the world of science. In the latter part of his address Major Close will give an account of the various ways in which the government departments have assisted the cause of geography, notably in the matter of mapping the empire. He will indicate the very large amount of this work which is being carried out all over the world, and will briefly describe some of the most important surveys. As regards the work of the section generally, an attempt has been made to arrange mainly for the discussion of a few subjects illustrating the advancement of geographical science, rather than for a multitude of separate papers. The way in which geography enters into every sphere of expanding activity will be demonstrated in a discussion on The Airman's Requirements, which it is hoped will be opened by Captain Bertram Dickson. Others expected to take part in this discussion are Captain Broke-Smith, of the Army Air Battalion; Mr. Eric H. Clift, Captain H. F. Wood, Captain Archibald R. Low, and Captain F. A. Sykes. A number of papers will relate to the sea. Mr. A. R. Hinks has promised a paper on the "Shape of the Sea Surface"; M. Ed. Henrici another on "Mean Sea Level"; Professor O. Pettersson will report the results of some "Recent Experiments on the Tidal Movements of the Deep Water of the Kattegat," and Dr. Gustav Ekman will describe some "Experiments with Automatic Current Measurements in the Open Sea." There will be a joint meeting with the geologists and botanists for the consideration of the relation of the present plant population of the British Isles to the Glacial Period, and probably another joint meeting with the geologists to discuss the former connection of the Isle of Wight with the mainland. Among various other contributions will be a lecture by Captain C. G. Rawling, of the British expedition to Dutch New Guinea, and a paper on "Mapping of Thermal Regions" by Professor A. J. Herbertson.

Section F (Economic Science and Statistics) will have as its president the Hon. W. Pember Reeves, formerly High Commissioner for New Zealand, and now Director of the London School of Economics. His opening address will deal with the subject of land taxation. In the later proceedings of the section, a discussion on land value taxes will be

opened by Mr. C. F. Bickerdike. Another discussion on Irish Finance will be opened by Professor C. H. Oldham. There will also be papers on "Variation of Wages," by M. Waxweiler, the Director of the Institut Solvay, Brussels; on "Destitution," by Mr. C. J. Hamilton; "Prison Reform," by Miss C. Smith Ronic; "The Merchant Service," by Mr. W. J. Hinton; "English Beet Sugar Industry," by Mr. Sigmund Stein, and the "State of Economic Science," by Mr. E. S. Grogan.

Section G (Engineering), which will meet under the presidency of Professor J. H. Biles, will have under consideration a number of subjects of great interest and importance. Besides the joint discussion with Section A on Aeronautics, to which reference has already been made, there will be a discussion on the respective merits of Super-Heated Steam Engines, Suction Gas Plants and Diesel Engines. Papers on these subjects will be contributed by Captain H. Riall Sankey, Mr. Tookey and Mr. Charles Day. It is hoped that Professor T. W. Howe will be able to show some interesting experiments on wireless telegraphy, and that Captain Sankey will be able to exhibit a portable wireless telegraphy equipment. Several papers relating to ships will be presented, dealing with recent improvements such as the Gyro-Compass (Mr. G. K. B. Elphinstone), Electrical Steering (Mr. B. P. Haigh), Electrical Drives for Ships' Propellers (Mr. H. A. Moor), and Marine Engines adapted for Burning Crude Oil (Mr. J. H. Rosenthal). Other papers will deal with the problem of Smoke Abatement (Dr. J. S. Owens), the Origin and Production of Corruption on Tramway Rails (Mr. Worby Beaumont), and the Vibragraph (Mr. Digby).

The president of Section H (Anthropology) will be Dr. W. H. R. Rivers, who will devote his address to a "Consideration of Ethnological Analysis of Culture." He will direct attention to the complexity of cultures often supposed to be simple and primitive, and will urge that the analysis of this complexity is a necessary preliminary to the study of the origin and development of institutions. The principles on which the analysis should be based will also be considered. As usual, a large number of papers on separate topics will be presented to the section, but a general discussion on the subject of totemism has been arranged. To this discussion papers will be contributed by Dr. A. C. Haddon, Dr. Kohler, Professor Graebner, M. A. van Geneep, Professor Hutton Webster, Dr. Goldweiser and Mr. Andrew Lang; it is hoped that Dr. C. G. Seligmann, Professor Fraser, Mr. R. R. Marett, M. Waxweiler, Mr. E. Thurston and Mr. E. S. Hartland will also take part in the discussion. The Roman portraits recently discovered in Egypt will be described by Professor H. M. Flinders Petrie, and some "Paintings in the Temple of the Tiger at Chichen Itza," by Miss A. C. Breton. The archeology of Peru will be discussed in a paper by Dr. Max Uhle. Major A. J. N. Tremearne has promised some "Notes on Hausa Folklore," and M. Malinowski a paper on the "Nature of the Australian Family." Ancient Britain will provide subjects for a number of papers, Mr. A. L. Lewis dealing with "Dolmens and Cromlechs," Mr. R. R. Marett with the "Recent Discovery of Pleistocene Man in Jersey," and Mr. W. Dale with "Prehistoric Man in Hampshire." "Paleolithic Man" will furnish the subject of a paper by Dr. A. Keith. Dr. F. C. Shrubsall will discuss the "Anthropology of Wessex," and "Some Unpublished Measurements of the Inhabitants of Dorset" will be presented by Mr. J. Gray.

Professor J. S. Macdonald, of Sheffield University, will preside over the deliberations of the physiologists (Section I). This section is one of those which usually receive a number of highly specialized papers capable of full appreciation only by the select few. This year, in addition to such contributions there will be three discussions of a wider range of interest, one on Sight Tests for Seamen, to be opened by Dr. C. F. Myers, followed by Dr. F. W. Edridge-Green; another on Ventilation in Confined Quarters, especially in Relation to Ships, to be opened

by Dr. Leonard Hill, followed by Professor N. Zunz, of Berlin; and a third on Inhibition, to be opened by Professor C. S. Sherrington, followed by Mr. Keith Lucas and Professor Macdonald. A report on Anesthetics will be followed by a paper on "Additions to the Use of a Chloroform Inhaler," by Professor A. C. Vernon Harcourt. Among a large number of other papers mention may be made of contributions by Professor Macdonald and Dr. J. E. Chapman on "Heat Production and Body Temperature during Rest and Work"; Dr. F. W. Edridge-Green, "Frequency of Color Blindness in Males"; Dr. Harriette Chick and Dr. C. J. Martin, of the Lister Institute, on the "Chemistry of Heat Coagulation of Proteins"; Dr. H. E. Roaf, "Some Considerations on the Influence of Hæmoglobin in the Hæmolysis of Red Blood Corpuscles"; Professor H. J. Hamburger, of Gröningen, "New Researches on Phagocytosis"; Dr. W. N. F. Woodland, on "Recent Views concerning the Physiology of Gas Production in connection with the Gas Bladder of Bony Fishes," and Dr. John Tait, various papers relating to the frog. An interesting exhibit, by Professor C. S. Sherrington, will be a model to illustrate Listing's law of the movements for the eyeball.

Professor F. E. Weiss will preside over Section K (Botany). A joint meeting has been arranged between this section and the Geological and Geographical Sections to consider the relation of the Present Plant Population of the British Isles to the Glacial Period. A general discussion on the subject will be opened by Mr. Clement Reid. Another discussion on the Principles of Construction of Phytogeographical Maps will probably be opened by Mr. A. G. Tansley. Additional interest will be lent to the proceedings of the section, and to these discussions in particular by the presence of a number of the most eminent continental and American plant geographers, who will be in England during August for an "International Phytogeographical Excursion to the British Isles." As the neighborhood of Portsmouth offers many attractions from the point of view of plant geography, excursions will play an important part in the program of the section. There will again be included in the "indoors" program a semi-popular lecture, which this year will be delivered by Mr. Francis Darwin. Other contributions to the sectional proceedings will include papers on "Phytogeography as an Experimental Science," by Professor Massart; "The Swiss National Park and its Flora," by Professor C. Schröter; "Some Petrified Jurassic Plants from Scotland," by Professor A. C. Seward; "Recent Work on Jurassic Plants of Yorkshire," by Mr. H. H. Thomas; "A Fifteen-Year Study of Advancing Sand Dunes," by Professor H. C. Cowles, of Chicago; "New Proposals in Ecology," by Professor F. E. Clements, of Minnesota; "The Vegetation of Pebble Beaches," by Professor J. W. Oliver; "The Seaweeds of a Salt Marsh," by Miss S. M. Baker; "The Water-content of Acidic Plants and the Wilting of Moorland Plants," by Mr. W. B. Crump; "The Morphology of Leguminous Nodules," by Professor Bottomley; "Nuclear Osmosis as a Factor in Mitosis," by Mr. A. A. Lawson; "Nuclear Division in *Spongospora*," and "The Polyphyletic Origin of the Cornaceæ," by Mr. A. S. Horne, and "The Transference of Sugar from the Host Plant to the Parasitic *Cuscuta*."

The Agricultural Sub-section is now attached to Section K. Its chairman, Mr. W. Bateson, proposes to devote his address to a consideration of the proper scope of an applied science, with special reference to the application of genetic research to agriculture and horticulture. The program of the subsection promises a series of most interesting and useful discussions and papers. Reference has already been made to the joint discussion arranged with the Chemical Section. Another discussion on How best the University Agricultural Department may come into Contact with the Farmer will be opened by Principal Ainsworth Davis, who will be followed by Mr. R. Hart-Synnot, dealing with the American and Canadian systems, and Mr. J. H.

Burton dealing with the place of the agricultural instructor. A third discussion on Bacterial Diseases in Plants will be opened by Professor M. C. Potter and further contributions to the consideration of the question have been promised by Mr. H. Priestley (Bacterial Diseases of Swedes and Celery), Mr. F. T. Brooks (Bacterial Gum Diseases), Dr. G. H. Pethybridge (Bacterial Disease of the Potato Plant in Ireland), Mr. G. T. Malthouse (Experiments on the Wart Disease of Potatoes), and Mr. A. Horn (Potato Disease). A popular lecture by Mr. A. D. Hall will discuss the soils and farming of the South Downs. Papers will also be contributed by Professor A. T. Wood, on "The Inheritance of Strength in Wheat"; Mr. B. T. P. Parker and Mr. V. F. Hillier, on "Cider Sickness"; Mr. S. U. Pickering, on "The Effects of Grass on Apple Trees"; Mr. J. H. Priestley and Mr. R. C. Knight, on "The Effect of High Tension Electric Discharges and Current Electricity on Plant Respiration"; Mr. C. C. Hurst, on "The Application of Genetics to Horse-breeding"; Mr. J. Wilson, on "The Inheritance of Milk Yield in Cattle"; Mr. J. Hindrick, on "The Effects of Ventilation on the Temperature and Carbon Dioxide of the Air of Byres"; Mr. J. Porter, on "Suggestions Relating to the Existing System of Imperial Avoirdupois Weights."

Bishop Welldon will preside over Section L (Educational Science), and proposes to take in his presidential address a general review of the existing educational system in Great Britain, particularly in England, with a view of suggesting some reforms in education, elementary, secondary and academical. He has been directly associated at different times with each of these three branches of education, as a fellow and tutor of his college, as headmaster of two public schools, and as a member of an education committee since he went to Manchester. His views will, therefore, be comprehensive in character, though necessarily he will be able to indicate only a few of the reforms which might be considered desirable in our educational system.

AUTOMATIC INCREASES IN SALARIES AT THE UNIVERSITY OF CALIFORNIA

The regents on May 9 confirmed the following recommendation of the Finance Committee:

That it be of record that with the adoption of the budget for 1909–10, the regents inaugurated a system of automatic increases in salaries, whereby an instructor's salary is increased automatically $100 per year from $1,000 to $1,500, and the salaries of assistant professors $100 a year from $1,600 up to $2,000; and that the automatic increases do not apply to members of the faculty below the rank of instructor, nor above the rank of assistant professor, and that there is no automatic increase after instructors have arrived at a salary of $1,500, and after assistant professors have arrived at a salary of $2,000; further, that increases are not automatic in salaries of members of the faculty who are on part time only, as, for instance, certain members of the departments of architecture and law, nor in the case of the affiliated colleges, the department of agriculture, the Wilmerding School, etc.; nor in the case of instructors and assistant professors for a year of absence on leave, the two-thirds salary while on leave being based normally on the salary of the previous year, unincreased; and, further, that increases may, of course, be given in the cases cited above, in which no automatic increase is due as of right. Larger increases than of $100 are of course sometimes made at the discretion of the president, with the approval of the regents.

SCIENTIFIC NOTES AND NEWS

The Paris Academy of Sciences has awarded its Lalande Prize to Dr. Lewis Boss. Its general prizes, each of the value of $2,000, have been awarded to M. Jules Tannery, of Paris, for his mathematical publications, and to M. Déperet, of Lyons, for his geological publications.

The Paris Academy has elected corresponding members as follows: Professor Levi-Civita, of the University of Padua, in the section of mechanics; Dr. Paul Wagner, director

of the Agricultural Station at Darmstadt, in the section of agriculture; Dr. Sven Hedin, of Stockholm, in the section of geography, and Professor Julius Bernstein, of Halle, in the section of physiology.

Dr. Ernst Ehlers, professor of zoology at Göttingen, has celebrated the fiftieth anniversary of his doctorate.

Mr. C. V. Gregory, bulletin editor and head of the agricultural journalism department at the Iowa College and Station, has resigned to become editor of the *Prairie Farmer* of Chicago.

Mr. H. H. Harrington, director of the Texas Agricultural Station, has resigned to become agricultural director of the St. Louis, Brownsville and Mexico Railroad.

Dr. Richard Möhlau, professor of the chemistry of dye-stuffs in the Technical Institute at Dresden, has retired from active service.

Professor H. C. Wilson, director of Goodsell Observatory of Carleton College and editor of *Popular Astronomy,* has returned after a sabbatical year spent at the Lick Observatory. The assistant editors of *Popular Astronomy* are both absent for the coming year, Dr. Ralph E. Wilson entering upon a two-year appointment at the Lick Observatory and Mr. Curvin H. Gingrich spending the year in study at the Yerkes Observatory.

Before an enthusiastic audience at the University of California Sir John Murray gave, on May 11, an account of his researches in the life of the deep sea and of his explorations of the structure and composition of the bottom deposits of the Pacific and Atlantic oceans. The lecture was illustrated by views of the deep-sea fishes discovered by the lecturer in his recent cruise on the Atlantic in the Norwegian fishery research steamer, *Michael Sars.*

The monument to Avogadro, erected to commemorate the centenary of the law which bears his name, will be unveiled at Turin on September 24.

Baron Arthur de Saint-Joseph, the entomologist who recently died, has bequeathed his collections and his library to the Paris Museum of Natural History.

Dr. Johann Paul Schweitzer, professor of chemistry in the University of Missouri from 1872 until 1910, when he became professor emeritus, has died at Columbia. He was born in Berlin in 1840 and came to the United States in 1865. He was known for his work in analytic and agricultural chemistry.

Professor E. Grawitz, director of the department of internal medicine in the municipal hospital at Charlottenburg, known for his work on diseases of the blood, died in that city on July 11, aged fifty-one years.

The U. S. Civil Service Commission announces that the government desires to secure a ceramic chemist who will be able to take charge of the ceramic section of the structural material work of the Pittsburgh laboratory of the Bureau of Standards, salary $3,000 to $4,000 per annum, depending upon the experience of the man available. The duties of the position will include the direction of the work of investigation and testing of clay and clay products. The qualifications of the persons under consideration will be passed upon by an impartial board of scientific men. Only persons of established reputation as ceramic chemists will be given consideration for this vacancy. As the selection for this position will be made about September 1, qualified persons who desire to be considered are invited to submit their names to the U. S. Civil Service Commission at Washington, D. C., before this date.

To counteract effects of exaggerated reports about the small earthquake in San Francisco on July 1, the newspaper publishers of that city have announced the results of a careful inquiry. Concurring in the findings are Hiram Johnson, governor of California, and other state and city officers, as well as the observatory chief at the University of California and the acting director of the Lick Observatory. "Absolutely no damage," the publishers' statement says, "was done by the shock in question to persons or property in San Francisco. . . . The only place in the state which

suffered in any degree from the quake was the Lick Observatory, conducted by the University of California on Mount Hamilton, Santa Clara County, seventy-five miles from San Francisco and twenty-five miles from San José. Even there the damage was nominal, except to buildings injured by the earthquake of 1906 and not adequately repaired.

Arrangements have been made by the trustees of Stanford University for the construction of the new Lane Library which is to be erected on the corner of Sacramento and Webster Streets, San Francisco, at a cost of $100,000. Excavation for the foundation has already been started and it is expected that the building will be ready for occupancy at the end of the school year. This building will house the Lane Medical Library which was founded by Dr. Lane, former president of Cooper Medical College, and the library of the Stanford medical department. The Lane Library was endowed by Dr. Lane and contains about 37,000 volumes, making it the largest library in the United States in direct association with a medical school.

The *Geographical Journal* says that among the Austrian workers in the direction of an improved scheme for the coloring of relief-maps, based on the optic properties of colors, Herr G. Freytag, of the Cartographical Institute of Freytag and Berndt, at Vienna, deserves credit for the results attained. Like Dr. Peucker he has been working at the question for some years, and has arrived independently at a solution, which is briefly described in a pamphlet issued by his firm this year. It is accompanied by a specimen relief-map colored according to the scheme adopted, the effect of which is perhaps as satisfactory as any of the attempts hitherto made in the same direction. The stereoscopic effect of the colors selected is well brought out by a pair of diagrams, in the first of which a square is colored with the reds in the center, these passing outwards through yellow to green and blue; in the other the order is reversed. The former gives the appearance of being raised, the latter of being depressed, in the center. The gradations are brought about by the differences in the tints, the strength remaining the same, so that violent contrasts are avoided.

In accordance with the resolutions passed on June 14 that the collections of the Geological Society should be divided between the British Museum and Jermyn Street, it is announced that the foreign series has already been removed to its new home at the British Museum (Nat. Hist.), is all in order in new cabinets, and can be referred to by responsible students.

The *Geological Magazine* remarks that the extraordinary richness of the collections of the British Museum has rarely been better illustrated than by the table-case of German Cainozoic Mollusca just arranged and exhibited in the geological department by Mr. R. B. Newton with the assistance of Mr. G. K. Gude. The accumulation of nearly a hundred years, there is a fine series of the land, freshwater and lacustrine shells which lived in Germany from Oligocene to Post-Pliocene times exhibited for the first time. No such series is to be found in any continental museum. Many of the specimens came from localities now closed or inaccessible, and such well-known places as Cannstadt, Heinheim, Oeningen, Mosbach, Budenheim, Floersheim, Mainz, Wangen, Weimar, Taubach, Hochheim, Wiesbaden, and a score of others are represented in the collection. Similar series of Mollusca from the other continental areas are in course of arrangement, the French and Austro-Hungarian being already in hand.

The electrical engineering department of the Massachusetts Institute of Technology received an appropriation of $3,000 from the Edison Electric Illuminating Company of Boston to be used in an investigation of the relative operating reliability and costs of electric trucks, gasoline trucks and horse trucking, for the purpose of determining to what degree electric trucks are adapted to compete with gas and horse trucks in the city of Boston. This investigation will cover the cost

of delivery of goods in the different ways. It will include all questions which concern electric trucks, including the influence of the different kinds of city pavements on cost of delivering goods, and the effects of different routings of the vehicles. The investigation will be partly theoretical, but it will be planned to determine practically what it ordinarily costs to deliver goods under city conditions. This part of the investigation will be accompanied by actual observations extended over a period of many months. At least a year will be occupied in this work, and Mr. H. F. Thomson has been appointed research associate to carry on the work under the direction of Professor Pender.

UNIVERSITY AND EDUCATIONAL NEWS

The physical laboratory at Göttingen has received gifts of $125,000 from Herr Krupp von Bohlen-Halbach and $40,000 from Herr von Boettinger.

We learn from the *Experiment Station Record* that the legislature has renewed for another period of five years the mill tax for the erection of buildings for the Iowa College and Station. It is estimated that over $1,000,000 will be available for this purpose durin the next six years. A library to cost $225,000 and a stock-judging pavilion to cost $20,000 are among the buildings definitely authorized. Special appropriations were also made of $60,000 for equipment of the domestic technology building, gymnasium and veterinary hospital, $6,000 for improvement of the grounds, $43,000 for the heating plant, $50,000 for general instruction, $18,000 for extension work, $15,000 for the station and $5,000 each for the engineering experiment station, the roads work and the two-year course.

The state board of education of Utah has provided that every accredited high school in the state must teach agriculture in order to participate in the maintenance fund provided for high schools.

The University of Athens will celebrate its seventy-fifth anniversary on March 25, 1912, at which time the International Congress of Orientalists will meet in the city.

The Consul General of Buenos Aires reports that a school of aviculture is to be established at La Plata as an annex to the zoological garden, to give instruction in poultry and bee keeping and in the rearing of rabbits and pigeons, the latter for consumption and as carriers.

The committee appointed recently by the board of regents of the University of Michigan to consider and report upon the organization of the Graduate School has been constituted as follows: President Hutchins, Regents Sawyer, Beal and Hubbard, Professor John O. Reed, dean of the faculty of literature, science and the arts; Dr. Victor C. Vaughan, dean of the faculty of medicine; Professor Fred N. Scott, chairman of the administrative council of the graduate school (at present a committee of the faculty of literature, science and the arts); Professor Alexander Ziwet, president of the Research Club; Professor R. M. Wenley, head of the department of philosophy. The committee will not convene till October.

The following appointments have been made in the medical department of Leland Stanford Junior University: Dr. Thos. Addis, Carnegie research scholar and fellow of the Royal College of Physicians of Edinburgh, to the position of assistant professor of medicine to have charge of the work in clinical chemistry; Dr. Jas. Eaves, of Edinburgh and of Guy's Hospital, London, instructor in surgery to have charge of surgical pathology. The following assistants were appointed to the medical dispensary: Dr. Geo. Lyman, Dr. W. H. Banks, Dr. W. R. P. Clark, Dr. Walter Schaller, Dr. P. H. Luttrell, and in the surgical dispensary Drs. W. W. Winterberg and I. W. Thorne. Provision has also been made for the appointment of an academic professor of obstetrics and gynecology.

Mr. D. B. Rosenkrants, recently of Upper Iowa University, has been appointed instructor in botany at the North Carolina College of Agriculture and Mechanic Arts.

THE Vienna correspondent of the *Journal* of the American Medical Association writes that at present there are two medical posts vacant in Austria: one at the clinic for internal medicine in Innsbruck, from which Ortner was called to Vienna to succeed von Strümpell, and the other at the pharmacologic institute of the German university in Prague. The latter has become vacant through Professor Pohl's acceptance of an appointment at Breslau. The following scientists have been recommended in the order named for the vacant post: for Innsbruck, Professor Pfeiffer from Graz, well known for his researches on serology, hematology and diseases of the lungs; Docent Dr. Schmidt (Vienna) and Professor von Tabora from Strasburg and also Professor Walks from Prague; for the pharmacologic institute, Professor Cloetta from Zurich, Professor Wiechowski, who is at present an assistant of Horst-Meyer in Vienna, and Professor Jodlbauer in Munich.

MR. HERBERT BOLTON, F.G.S., curator of the Bristol Museum of Natural History, has been appointed reader in paleontology in the University of Bristol.

DR. SAMUEL OPPENHEIM, of Prague, has been elected professor of astronomy in the University of Berlin.

DISCUSSION AND CORRESPONDENCE

CONCERNING THE "NEMATOCYSTS OF MICROSTOMA"

PROFESSOR GLASER in SCIENCE of July 14, 1911, has criticized my recent paper on "Nematocysts of Microstoma."[1] In the first place he indicates that I have made a quotation from his paper and given credit for it to Boulenger. This was a piece of carelessness on my part. That it was an inadvertence is shown in that the page numbers given refer to Glaser's article, to which I meant to give credit. I greatly regret that this blunder has been made and I am grateful to Professor Glaser for calling my attention to it.

[1] *Biological Bulletin*, Vol. XX., No. 5.

My critic continues by saying, "Professor Kepner states that the cnidophages of æolids deliver their nematocysts to the cnidocyst, whereas the endodermal cells of *Microstoma* deliver their nematocysts to the mesoderm. Unfortunately for the analogy, both Grosvenor and I have shown that the cnidophages after engulfing a certain number of nettles, metamorphose directly into cnidocysts."[2] I had attempted to make no *analogy* in this case nor was I concerned with the manner in which the cnidocyst was formed. I had attempted to make a *comparison*. The cnidophages of æolids by metamorphosing to form the cnidocysts do not involve the mesodermal cells and thus may be *compared* with the endodermal cells of *Microstoma* which deliver the nematocysts to the mesoderm.

Professor Glaser in the third place criticizes me for quoting Grosvenor in support of the idea that the nematocysts of æolids are of defensive value, and at the same time overlooking the work of Cuenot and Glaser which showed that the "defensive value of the nettles is slight if not negligible." I had not overlooked this work of Cuenot and Glaser on the nematocysts of æolids. Despite this negative evidence I am constrained to believe that the nematocysts of *Microstoma* are of defensive value.

Finally my critic states that I have raised the question whether æolids have acquired their method of dealing with nematocysts of cœlenterates through flatworm ancestry. This question was suggested. Professor Glaser, however, is unfair to me in not stating that I had placed by the side of this the alternative question whether we had here cases of parallel development. Two questions, not one, were thus raised by me, and I feel quite unready to defend either hypothesis.

Giving credit to whom credit is due, the fact remains that the endodermal cells of *Microstoma* collect the nematocysts of *Hydra* to deliver them to mesodermal cells. Certain mesodermal cells transport these nematocysts to and orient them at the ectoderm.

This intricate process has no meaning un-

[2] SCIENCE, Vol. XXXIV., July 14, 1911, pp. 51–2.

less the nematocysts have important defensive value to the flatworm.

WM. A. KEPNER

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July 15, 1911

SCIENTIFIC BOOKS

Convergence in Evolution. By ARTHUR WILLEY. London, John Murray. Pp. 177, 12 figs. 1911.

In "Convergence in Evolution" Professor Willey has written an illuminating exposition of the wide-spread occurrence of convergence in animal structure and habit, and a strong argument for a fairer recognition of its validity and importance. Indeed, this argument is sometimes so strong, at least in its wording, that it seems almost to overshoot the mark. It makes convergence seem too important, too dominant, too universal, to be true. For example—perhaps a slightly unfair one, wrested thus from its context—Professor Willey says of histologic identity:

> In the light of facts which are now available it even begins to appear strange, although only a matter of a few years or months ago, that histological identity should ever have been insisted upon as a criterion of homology except within well-defined limits (p. 153).

But despite his enthusiasm for convergence and his avowed intent to unseat homology from its high place, Professor Willey never means to be unfair. He is simply a convinced believer, a positive expositor and a strong debater. He asks only for a recognition of the facts. He has no laws of convergence to offer any more than he will agree to accept any one universal criterion of homology.

> Then away with laws and away with criteria until they cease to obscure the facts as they are (p. 170).

The book is thoroughly interesting reading for a zoologist. It is a mine of illustrations of adaptive convergence. Indeed, it might be offered as a reference book of animal adaptations. Examples of extraordinary similarities in superficial and histologic structure in all parts of the bodies of animals of all the phyla crowd the pages of the book. For not a few of these the author is able to draw on his own contributions to the knowledge of animal morphology. For the others he usually gives satisfactory references.

I am tempted to take out of the book some of the choice examples. But I shall be doing my readers a greater favor if by refraining from doing this, and at the same time telling them how interesting and suggestive many of of these examples are, I can induce them to see the whole book. To read it as a whole is the more desirable also because of the unusually independent and original points of view from which the author examines many current biological theories and problems. Indeed the book is so refreshing and stimulating in its forthright outspokenness with regard to much that many of us feel insurgent about but hesitate to speak out about, that it is worth while for this alone. All the convergence in it will be surplus for your money!

Just one thing to act as "snapper" at the end of this otherwise unmitigated enthusiasm of commendation. The style in which the book is written is unfortunate. Not as to sentence construction, paragraphs, grammar, punctuation, but as to abruptness of attack and of leaving off; of pertinence of matter to subject, of illustration to point. One loses his bearings too often in the book. One wonders whether this example belongs to the subject behind it or to the one in front of it. Or indeed whether it belongs in the book at all. But readers of scientific books are, from long experience, immune to most of the difficulties which unusual manners of writing can present. They are accustomed to dig their gold wherever and however they find it concealed. And Professor Willey's book has much good gold in it for any digger.

V. L. K.

STANFORD UNIVERSITY, CAL.

A Monograph of the Naiades of Pennsylvania. By ARNOLD E. ORTMANN, Ph.D. Memoirs of the Carnegie Museum, IV., No. 6, February, 1911, pp. 279–347; pl. 86–89; 4to.

This memoir—confined to a discussion of the anatomical characters, especially the structure of the gills, and to an arrangement of the different groups in conformity with the data newly obtained or now correlated by Dr. Ortmann—comprises an important advance in our knowledge of the fresh-water mussels. Giving full credit to Lea and Simpson, pioneers in the classification of these animals on the basis of the characteristics of the reproductive organs and marsupium, the author's studies of the microscopic structure of these organs have enabled him to rectify some errors and add very largely to the available data. The details are well illustrated both by text figures and excellent plates. The description and illustration of the Pennsylvanian species is reserved for future publication.

Dr. Ortmann, on account of certain archaic features, proposes for *Magaritana* a separate family, retaining the other Pennsylvanian forms in the Unionidæ which he divides into three subfamilies. He proposes a new genus *Paraptera* for *Lampsilis gracilis* (Barnes) on account of peculiarities of the glochidia. We note that he adopts for the group commonly known as *Glabaris* the name of *Anodontites* which was first applied by Bruguière. This name is undoubtedly prior to any other for the group in question, but by the rules in vogue, at the time it was proposed the termination *ites* was reserved for fossil species, and it was therefore not adopted. If *Anodontites* be rejected *Patularia* Swainson precedes *Glabaris* in date.

WM. H. DALL

The Sources and Modes of Infection. By CHARLES V. CHAPIN, M.D., Sc.D., Superintendent on Health, Providence, R. I., author of Municipal Sanitation in the United States. New York, John Wiley and Sons; London, Chapman and Hall, Limited. Octavo. Pp. ix + 399. 1910.

Any book written by this author is worthy of attention, and this one especially so—for in it is contained a summary of our knowledge of the subjects of which it treats and the interpretation put upon this knowledge by one possessed of wide experience. Some of the conclusions arrived at will be startling to those unfamiliar with the general trend of modern thought, but none are put forward that are not logically in sequence to the evidence presented. It will be difficult to secure general acceptance of such conclusions as this (p. 28): "While municipal improvements, such as the above" (cleaning of streets, back alleys, etc., regulation of offensive trades and prevention of nuisances generally), "are advisable, there is little more real reason why health officials should work for them, than there is that they should work for free transfers, cheaper commutation tickets—all good things in their way and tending towards comfort and health." Yet the author brings forward apparently good evidence to show that such statements are warranted. Perhaps the most valuable chapter is the second—in which stress is laid upon "carriers and missed cases" as most important sources of infection. Attention is called to the great influence of infection by contact—the comparative slight importance of infection by fomites or by air; instances are given of the favorable results following the abandonment of disinfection in certain of the infectious diseases in Providence, and a proper amount of stress is laid upon the transmission of certain diseases by insects. For all who are interested in these subjects the book will be a valuable aid in recognizing the present evidence upon which the control of infectious diseases must rest.

HAROLD C. ERNST

HARVARD MEDICAL SCHOOL

BOTANICAL NOTES

A READABLE BOOK

AMONG the most readable of recent botanical books is that on "The Evolution of Plants," by President D. H. Scott, of the Linnean Society of London (New York, Holt). In about two hundred and fifty duodecimo pages the author discusses the evolution of plants most entertainingly and lucidly, confining himself, however, to the flowering plants and the "higher spore plants."

The scope of the work may be appreciated from the chapter headings, which include a discussion of the Darwinian theory, the nature of the evidence, the fossil record, the problem and the evidence in regard to seed plants, evolution of ferns, club-mosses, horsetails and sphenophylls. There is a handy glossary for the non-botanical reader, and a brief bibliography.

We may close this brief notice by quoting a paragraph from the author's "conclusions" (p. 29):

The first and most obvious result of our inquiries is to prove the enormous antiquity of highly-organized plants. If a botanist were set to examine, without prejudice, the structure of those Devonian plants which have come down to us in a fit state for such investigation, it would probably never occur to him that they were any simpler than plants of the present day; he would find them different in many ways, but about on the same general level of organization. Within the period from the Devonian age to our own time organization is not shown to have "largely advanced," though there have been many changes. It is not contended that there has been no advance; the special adaptations of the Flowering Plants to Insect life and in other ways show progress in many directions, corresponding to increased complexity in the conditions of life. It must be borne in mind, however, that we know very little as yet about such special adaptations among plants of earlier periods.

A NEW TEXT-BOOK OF BOTANY

NINE years ago Professor Dr. Henry Kraemer brought out the first edition of a book under the title of "A Text-book of Botany and Pharmacognosy" which the present reviewer was glad to commend as an effort to secure a better botanical foundation for students of pharmacy. Since then two editions have appeared (1907, 1908) and now we have a fourth edition (Lippincott, 1910) much enlarged and improved. The plan of the work remains practically the same as in the earlier editions. Part I. is devoted to botany and includes chapters on the principal groups of plants, the outer morphology of angiosperms, the inner morphology of the higher plants, classification of angiosperms yielding vegetable drugs, and cultivation of medicinal plants. In looking over this portion of the book, which covers more than 400 pages, the botanist is struck with the fact that at last the medical men of America have awakened to the fact that the botanical foundation for their students must be broad and solid. The treatment in this portion of the book is so entirely different from that which has too often been given to medical students that there is no similarity whatever. It is very good indeed and the author is to be congratulated upon his interpretation of the methods of the modern study of pharmacy.

Part II., covering about 300 pages, is devoted to pharmacognosy and includes two chapters, the first and longest being devoted to crude drugs and the second to powdered drugs and foods. The remaining parts, which include about 50 pages, are devoted to reagents and technique and micro-analysis.

The author has a keen sense of the need of the particular treatment which he has given the subject, as is shown by his statement that "while there are some teachers who naturally prefer their students to have an independent course in botany before taking up pharmacognosy, the treatment of this subject in this books is such as to be directly applicable to pharmaceutical work, and will be found useful to the student of pharmacy in the college course, as well as of assistance to the pharmacist and analyst who engages in practical pharmacognostical work." With this statement the present reviewer most heartily agrees. In fact, he has looked over these earlier chapters and has wondered whether the purely botanical portion would not be a most excellent text-book in botanical laboratories. Certainly in this day when we are trying to relate our sciences more and more to their applications, the treatment here is most suggestive and commendable.

Dr. Kraemer has introduced an interesting feature in his study of drugs in suggesting simple methods by which the crystalline extracts may be obtained by the student. This, no doubt, will add very greatly to the interest

of the study and is a feature to be greatly commended.

CHARLES E. BESSEY
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SPECIAL ARTICLES

PROGRESSIVE VARIATION IN DECAPTERUS, A GENUS OF CARANGOID FISHES

IN the fishes of the genus *Decapterus* which the writer has examined here and abroad, six forms are recognizable, making a series from species which perhaps belong rather to *Caranx*, to the most extreme *Decapterus*. Typical *Decapterus* departs from the *Caranx* type in being less deep, less compressed, in having the last ray of the dorsal and anal fins separate from the rest of the fin, forming a mackerel-like finlet, and in possessing a bluntly pointed protuberance with a groove beside it, on the shoulder girdle under the edge of the gill cover, suggesting a not dissimilar structure in *Trachurops*, but less pronounced. The most *Caranx*-like of the six is *Decapterus affinis* of the Pacific and Indian Oceans. The four middle forms are intermediates between this and the least *Caranx*-like, *D. macarellus*. This progressive variation is readily explicable by a very attractive theory of variation with migration, submitted for what it is worth.

The six forms are:

1. *D. affinis* (Rüppel). Figured by Day ("Fauna British India, Fishes") and Jordan and Seale ("Fishes of Samoa," *D. lundini*). Specimens have been examined in the British Museum.

Depth 3.5 in length to fork of caudal. Anal soft rays 20–22. Lateral line with 50–53 scales followed by 42–47 scutes. Last ray of dorsal and anal not detached from the rest of the fin. Teeth small, evident.

Range—Pacific and Indian Oceans.

2. *D. rhonchus* (G. St.H.). A specimen examined in the Paris Museum.

Depth 4.0. Anal soft rays 25–27. 56 scales followed by 23–26 scutes in the lateral line. Last ray of dorsal and anal not detached. Teeth small, evident. Without the peculiar shoulder structure mentioned above.

Range—north and west coasts of Africa.

3. *D. maru-adsi* (Temminck & Schlegel). A specimen examined in the Paris Museum. Cat. Fish, Brit. Mus. II.

Depth 4.5. Anal rays 28. 50 scales followed by 36 scutes in lateral line. Last rays dorsal and anal detached from the remainder of the fin. Teeth minute, evident. With the peculiar shoulder structure.

Range—Japan and China coasts.

4. *D. kurra* (Cuv. & Val.). Day, Fauna British India, Fishes. The type of *D. kiliche*, C. & V., examined in the Paris Museum.

Depth 5.0. Anal rays 26. 47–55 scales followed by 33 scutes in lateral line. Last rays dorsal and anal detached. Teeth minute, evident. Peculiar shoulder structure present.

Range—Indian Ocean.

5. *D. punctatus* (Ag.). Specimens examined in the Paris Museum labelled *D. punctatus* and *D. kurroides*. Bull. 47, U. S. National Museum.

Depth 5.0. Anal rays 25. 56 scales followed by 32 scutes. Last dorsal and anal rays detached. Teeth minute, evident. Peculiar shoulder structure present.

Range—Atlantic Ocean.

6. *D. macarellus* (Cuv. & Val.). Types of *D. macarellus, pinnulatus, jacobæus* and *scombrinus*, examined in the Paris Museum. *D. macarellus* and *D. sanctæ-helenæ*, Bull. 47, U. S. National Museum.

Depth 5.5–6.0. Anal rays 28–31. 94–96 scales followed by 28–30 scutes. Last dorsal and anal rays detached. Teeth not evident. Peculiar shoulder structure present.

Range—Atlantic and Pacific Oceans.

Nos. 1 and 2 of this series would perhaps fit better in *Caranx* than in *Decapterus* (being more or less intermediate between *C. djedaba* and the genus *Decapterus*). Specimens of *rhonchus* and *maru-adsi* placed side by side resembled one another very much, the most noticeable differences being the imperfectly separated last dorsal and anal rays, and absence of shoulder peculiarity in *rhonchus*. *Punctatus* is much less compressed than *maru-adsi*, and *kurra* intermediate between these two as is its range. These three

are the most closely related forms. Between *punctatus* and *macarellus* is a sharp break.

An explanation of the distribution of the forms is that *affinis* spread from the Indian Ocean westward around the world. The form differentiated in the Atlantic was *rhonchus* and in the Pacific *maru-adsi*, species whose range has since been restricted to Africa and Japan and China, but still the westward migration continued, *maru-adsi* migrated into the Indian where it became *kurra*, separated by intermediate stages from the *affinis*, which had been there since the beginning and still pushing westward became *punctatus* in the Atlantic and *macarellus* in the Pacific.

With this theory as a view-point the thing that immediately calls for explanation is the relation to one another of the two final forms *punctatus* and *macarellus*, and of their ranges. The forms are so strongly differentiated as to presuppose long separation by a barrier as of land, yet they are the only adjoining members of the series occurring in the same waters, as they do in the Atlantic. A land connection from Africa to South America would obviate this difficulty as the two forms would at once have invaded one another's Atlantic ranges when this barrier was removed. Also we must explain the peculiar range of *macarellus*, found in Atlantic and Pacific, but not in the Indian, which may be readily done by supposing that the North and South American land connection is of recent origin.

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THE AMERICAN CHEMICAL SOCIETY

The Effect of the Club Root Disease upon the Ash Constituent of the Cabbage Root: Howard S. Reed.

The ash analysis of healthy and diseased cabbage roots reveals appreciable variations in the amounts of certain constituents while others vary but slightly. In the diseased roots there was an appreciable increase in the amounts of calcium, magnesium, phosphoric acid, potassium and sulphuric acid, *i. e.*, an increase in the amount of "essential" elements.

The greatest increase of any single constituent was in the case of potassium. The increase of potassium appears to be coupled with an increase of protoplasmic substance and accumulation of starch.

The proportion of calcium to magnesium is greater in the diseased roots. The same is also true of the proportion of potassium to sodium, but there is no material difference in the proportion of magnesium to phosphorus. The differences in the amounts and proportion of ash constituents appear sufficiently well marked to indicate a more or less definite correlation in the metabolism both of healthy and of diseased plants.

Effect of Frost on the Aromatic Constituents of the Peppermint Plant: Frank Rabak.

The Volatile Leaf-oil of the Washington Cedar, Thuja plicata: Robert E. Rose and Carl Livingstone.

Absorption and Excretion of Salts by Roots, as Influenced by Concentration and Composition of Culture Solutions: I., Concentration Relations of Dilute Solutions of Calcium and Magnesium Nitrates to Pea Roots: R. H. True and H. H. Bartlett.

Creatinine in Plants and in the Medium in which they Grow: M. X. Sullivan.

The Effect of Temperature on the Respiration of Fruits: H. C. Gore.

The Phosphorus Assimilation of Aspergillus niger: Arthur W. Dox.

(From the Chemical Section of the Iowa Agricultural Experiment Station.)

The necessity for some form of phosphorus in culture media for lower fungi has long been recognized. Notwithstanding the variety of phosphorus compounds occurring in nature, very few have been tested with regard to their availability as sources of this element for mold cultures. Among the substances tested in this experiment were phytin, sodium glycerinophosphate, sodium nucleinate, lecithin, casein, ovovitellin, ortho-, pyro- and metaphosphates, hypophosphites and phosphites. All but the last two, which contain trivalent phosphorus, were readily utilized.

Fermentation and Putrefaction: Arthur I. Kendall.

(From the Department of Preventive Medicine and Hygiene, Harvard Medical School.)

As shown by the work of the author and others, utilizable carbohydrates protect nitrogen from attack by bacteria. This finds its analogue in the metabolism of higher forms. Fermentation takes precedence over putrefaction. For the purposes of this paper, by fermentation is meant the

action of bacteria upon carbohydrates; while by putrefaction is meant the action of bacteria upon nitrogenous substances. The two phenomena, fermentation and putrefaction, are antagonistic processes: the obligate putrefactive bacteria can not, as a rule, grow in media in which active fermentation is going on, because the acids produced inhibit their development. There is a third group, the facultative organisms, which are able to adapt themselves to both kinds of food. This is an important new conception. Thus in the presence of dextrose the diphtheria bacillus elaborates no toxin, while in its absence large amounts are formed. *B. coli* behaves similarly. Not only do the products vary, but the composition of the bacteria themselves may be altered. All these considerations will prove of great importance in practise.

The Carbon Nitrogen Ratio in the Decay of Protein Compounds: JACOB G. LIPMAN.

Biochemical and Toxicological Studies upon Penicillium: C. L. ALSBERG and O. F. BLACK.

A Study of the Optical Forms of Lactic Acids produced by Pure Cultures of B. bulgaricus: JAMES N. CURRY.

Nucleic Acid in Soils: EDMUND C. SHOREY.

Conditions for Tannic Acid Fermentation: LEWIS KNUDSON.

As a result of the fermentation of tannic acid (gallotannic), gallic acid is formed. Van Tieghem first showed that the fermentation of this substance may be effected by the two organisms *Aspergillus niger* and *Penicillium glaucum*. Pottevin and Fernbach simultaneously reported the extraction of the enzyme tannase, the transforming agent. Since that time several other investigators have contributed to the subject.

Experiments made by the writer indicate that if tannic acid alone is offered as a source of carbon, the gallic acid formed as a result of the tannic acid transformation is utilized in the metabolism of the organism—the greater the growth of the fungus, the greater is the decrease in tannic acid. It is likewise shown that the duration of growth, the presence of other nutrients and aeration—factors influencing growth mass—were important considerations with respect to the yield of gallic acid.

An infusion of gall nuts contains, in addition to tannic acid and gallic acids, other organic compounds as well as inorganic salts. When cultures are made in which the gall nut infusion is used as the nutrient solution, the tannic acid is transformed; but the gallic acid is not at first utilized. The organism seems to elect the other organic compounds first and then some of the gallic is utilized. There is then an election of food by the organism.

If there is offered to *Aspergillus niger* or *Penicillium* sp. in a nutrient salt solution, 10 per cent. cane sugar along with 13 per cent. tannic acid, then the sugar entirely protects the gallic acid formed from assimilation, or use as food by the fungus. A 5 per cent. concentration of sugar is not sufficient to protect the gallic acid, during the growth interval employed.

Experiments were also made in which the fermentation cultures were kept under anaerobic, and also limited oxygen conditions, and the results obtained were compared with those in which growth was permitted under more favorable conditions of aeration and nutrition.

Regulatory Formation of the Enzyme Tannase: LEWIS KNUDSON.

The work of Fermi, Pfeffer, Katz, Went, Dox and others has shown that to a considerable extent the formation of enzymes is influenced markedly by the nutrition of the organism. According to Dox, the production of those enzymes that are not normally developed by the organism in demonstrable quantities can not be induced by any special nutrition. This statement is not in accord with the results obtained by Went; nor with the more recent work of Harden and Norris working with yeast, wherein it is shown that there may be induced by special nutrition an enzyme which normally did not occur in the yeast plant. The work of the writer, herewith briefly reported, is also in disagreement with the results of Dox.

The two organisms, *Aspergillus niger* and *Penicillium* sp., which normally develop on commercial gall nuts when these are moistened and exposed to the air, produce the enzyme tannase; and this enzyme is capable of effecting the transformation of tannic acid into gallic acid and glucose.

Pottevin found that the enzyme tannase was formed in *Aspergillus niger* when it was grown in Raulin's solution in which the sugar was replaced by tannic or gallic acid. The writer has grown the organism in synthetic solutions in which the carbon nutrient, cane sugar, was replaced entirely or supplemented by one of several carbon compounds. In the experiments the effect of each of fourteen different carbon compounds was tested, but the enzyme tannase was produced only when the sugar was replaced by tannic or gallic acid,

or supplemented by tannic acid. The gallic acid, furthermore, was not as efficient as the tannic acid in stimulating the formation of the enzyme.

Some work has been done showing that the quantity of a particular enzyme produced irrespective of the character of the carbon nutrient, can be increased in amount by offering the organism the carbon compound which is transformed by the enzyme in question. No work apparently has been reported on the effect of concentration of the transformable substance on the quantity of the corresponding enzyme produced. Employing the two organisms mentioned, the writer made experiments, in which a modified Czapek's solution was the nutrient medium—in this the concentration of sugar was made 10 per cent., and it was supplemented by tannic acid in concentrations varying from 0.01 per cent. to 10 per cent. The quantity of the enzyme produced was augmented by increase in concentration of the tannic acid. None, however, was formed when the concentration of tannic acid was as low as 0.01 per cent.

Similar results were obtained with *Penicillium* sp. *Aspergillus candidus*, *Aspergillus oryzæ* and *Penicillium granulatum* cultivated in a synthetic solution in which the carbon was supplied as 5 per cent. cane sugar and supplemented by 2 per cent. tannic acid also developed the enzyme tannase. *Penicillium expansum* in a similar solution did not develop the enzyme.

The enzyme tannase would fall then in the third class, as described by Went, which class includes only those enzymes which are produced when a particular carbon compound is present in the nutrient solution.

The Synthesis of Fats by the Action of Enzymes: F. L. Dunlap and L. O. Gilbert.

Five grams oil-free castor bean, 5 g. flaxseed, 25.5 g. glycerol, 16.7 g. Kahlbaum's oleic acid were triturated in a mortar till emulsified. The flaxseed was introduced to perfect the emulsion. It is without action. This emulsion was allowed to stand and its acidity titrated at intervals. After eleven days the loss of acidity was such as to correspond to a disappearance of over 26 per cent. of the total oleic acid present, so that the enzyme of ricinus has undoubted synthetic power.

On the Measurement of the Oxidase Content of Plant Juices: H. H. Bunzel.

The Pigmentation of the Adult Periodical Cicada, with a Note on Chemical Anti-oxidases: Ross Aiken Gortner, the Carnegie Institution of Washington.

The black pigment of the periodical cicada (*Tibicen septendecim* L.) is shown to be produced by the interaction of a chromogen and an oxidase of the tyrosinase group. Coloration proceeds after death but does not produce the normal uniform coloration, since, apparently, the tyrosinase is secreted together with the new cuticula, and after death this secretion ceases.

In the note on chemical anti-oxidases the suggestion is made that, perhaps, dominant whites are due to the presence of aromatic compounds carrying two hydroxyl groups in meta position to each other. It was noted that tyrosin did not produce the typical coloration in the presence of tyrosinase when orcin, resorcin or phloroglucin—all meta-di-hydroxyl benzol derivatives—were present in the solution. This result was, apparently, caused by the tyrosinase being affected in the same manner as though an anti-oxidase were present, for proof was given that the tyrosin had not united chemically with the m-di-hydroxyl compound, and data were also given which makes it appear very improbable that the cause lies in a more rapid oxidation of the orcin, etc., to colorless derivatives. The only other alternative is that the action is of the same nature as that of a true anti-oxidase. If, therefore, through some body process, an additional hydroxyl were added to tyrosin adjacent to the alkyl chain, a compound would result which should not give colors with tyrosinase, nor allow colors to be produced even though tyrosin were present. Such a situation would produce dominant whites.

A Study of the Methan Fermentation in the First Stomach of Ruminants: Sleeter Bull.

Crude fiber, or cellulose and starch, undergo a fermentation in the paunch of ruminants with the formation of methane carbon dioxide, acetic acid, butyric acid and isobutyric acid.

By the artificial fermentation of cellulose it was found that 1.0 gm. of cellulose produced .033–.040 gm. of methane.

Omeliansky found that one gram of cellulose produced .068 gm. of methane, .3057 gm. of acetic acid and .2038 gm. of butyric and isobutyric acid.

Knowing the energy value of the cellulose—4.220 cals.—and that of the products of the fermentation, it may be computed that 1.4048 cals. of energy are liberated as "heat of fermentation" in the fermentation of one gram of cellulose. Expressed in terms of methane, 1.1549 cals. of energy are lost as "heat of fermentation," for every calory of methane excreted by the animal.

Applying this factor to results of experiments upon steers with the respiration calorimeter at the Institute of Animal Nutrition of the Pennsylvania State College, in which the amount of methane excreted and the amount of heat emitted after the ingestion of a known amount of food were determined, it is found that in the case of a hay ration 32 per cent. of the "heat of digestion" arose from the methane fermentation of the carbohydrates.

Effects of the Quantity of Protein Ingested on the Nutrition of Animals: II., On the Weight of some of the Vital Organs of Lambs: W. D. Carroll and A. D. Emmett.

Effects of the Quantity of Protein Ingested on the Nutrition of Animals: III., On the Ash and Total Phosphorus of Flesh from Lambs: R. H. Williams and A. D. Emmett.

Effects of the Quantity of Protein Ingested on the Nutrition of Animals: IV., On the Creatin of Flesh from Swine and Lambs: W. E. Joseph and A. D. Emmett.

A Cage Designed for Metabolism Experiments on Goats: A. R. Rose.

In this station it was found most practical, when using the cow, in metabolism experiments, to keep men constantly on the watch to collect the excreta. This method is exceedingly laborious, and a smaller animal which could be caged easily was sought as a substitute for the unwieldy cow. For this purpose the goat serves admirably, and it is rather remarkable that an animal with so many qualifications for metabolism work has received so little attention. The goat is of convenient size to be readily handled, and it takes rations and yields excreta of very satisfactory bulk and might very well represent the herbivora in animal experimentation. It becomes quickly at home in the cage and adjusted to the demands of the investigator.

The cage consists essentially of an elevated wooden box, with gratings in the upper part, to admit light and air. Inside wooden walls are covered by galvanized sheet iron. One side is attached only at the top by means of hinges, and forms a door to admit or remove the goat, and for convenience in milking.

The floor is a heavy wire screen with wires sufficiently far apart to let all waste pass through, yet allowing five wires for each foot to rest upon.

Under the screen, at the front end, is a pan to collect any food dropped in eating. Under the rest of the floor is the device for separating the excreta from one another, consisting of two galvanized sheet iron parts, the hopper and urine pan. This hopper terminates in a trough leading toward the front end of the cage. This trough has at the point of junction with the hopper, an opening in its bottom protected by strands of wire, by which the dung pellets coming down the hopper are deflected into a suitable removable receptacle standing on the floor under the front end of the cage. The urine passes through this hole into a shallow pan suspended from the hopper trough, immediately beneath. This pan has an elongated spout leading forward through which the urine flows into another receptacle standing on the floor beside the one provided for the dung.

The cage is simple in construction. It was made by local carpenters with the aid of a tinsmith, at a cost of thirty-seven dollars. The complete cage occupies a floor space of about two by four feet, is seven feet high and can be easily carried by two men. The cage is equally applicable to studies on sheep.

On the Lipins of the Heart Muscle of the Ox: Jacob Rosenbloom.

(From the Laboratory of Biological Chemistry of Columbia University, at the College of Physicians and Surgeons, New York.)

MacLean[1] has found that the essential fat of the liver has the properties of phospholipin. He thinks it probable that the fatty matter from certain other organs is of the same nature. He finds by extraction of the liver with ether and alcohol, at room temperature, that 84 per cent. of the total extract is phospholipin in quality, whereas, if the extraction is carried out at the temperature of the *boiling* solvent, only about 40 per cent. of the extract partakes of the properties of phospholipin. MacLean believes that such treatment with the *boiling* solvent causes a cleavage of the tissue phospholipin, with a consequent increase in the amount of neutral fat in the extract.

In a study of the lipins of the heart muscle of the ox, practically identical percentages of neutral fat and phospholipin were found by the writer in the ether and alcohol extracts which had been obtained by treatment with the respective solvents at room temperature and also at their *boiling* temperatures. It is possible, however, that the ether and alcohol extracts of the liver contain substances of a lipin nature which are more easily

[1] MacLean, *Biochemical Journal*, 1909, IV., p. 455.

decomposed than those in similar extracts of heart muscle.

The Effect of Pregnancy on the Lipins of the Ovary and Corpus Luteum of the Cow: Jacob Rosenbloom.

(From the Laboratory of Biological Chemistry of Columbia University, at the College of Physicians and Surgeons, New York.)

A comparative study of the amounts of neutral fat, fatty acid, lecithan and cholesterol, in ether and alcohol extracts of the ovary and corpus luteum of the cow, showed that pregnancy had no effect on the respective proportions in which these substances appeared in the extracts.

Relation of Permeability to the Fertilization of the Ovum: E. P. Lyon and Shackell.

Demethylization under Normal and Pathological Conditions: I., Chronic Alcoholism: Wm. Salant and I. K. Phelps.

Elimination of Caffein in the Urine: Wm. Salant and J. B. Rieger.

The Effect of Diet on Resistance to Drugs: Wm. Salant.

The Stability of the Photogenic Material of the Lampyridæ and its Probable Chemical Nature: F. Alex McDermott.

The photogenic compound present in the Lampyridæ is much more stable towards atmospheric oxygen than has usually been thought, especially when dried out of contact with air; it presents many points of similarity to other known biologic products; from embryologic and chemical considerations it appears probable that it is a lipoid or lecithin.

Gases of Swiss Cheese: William M. Clark.

The Brine Soluble Compound found in Cheese: L. L. Van Slyke and Alfred W. Bosworth.

(Chemical Laboratory, New York Agricultural Experiment Station, Geneva, N. Y.)

Investigations which have been conducted in this laboratory during the past years have shown that during the ripening of cheddar cheese a form of protein is always produced which is soluble in a 5 per cent. sodium chloride solution. The presence of this brine-soluble compound was shown to be connected in some way with the development of acid in the cheese. The compound was at first erroneously supposed to be paracasein-monolactate and later free paracasein. In recent work it was noticed that calcium was always to be found associated with this brine-soluble compound when it was separated from the other cheese constituents by extraction with solution of c.p. sodium chloride (free from calcium), after first removing the water-soluble constituents.

This brine-soluble compound is always present in cheddar cheese. In a cheese two years old 40 per cent. of the nitrogen was present in this form. It is also a fact that in cheddar cheese all of the calcium is never extracted with water, part of it always being found in the brine extract. In camembert cheese, however, the reverse is found. After the first few hours this cheese contains no brine-soluble compound and all the calcium is found in the water extract. The brine-soluble compound is formed in this cheese, but, owing to the method of making, more acid is allowed to develop than in cheddar cheese and, as a consequence, the brine-soluble compound loses its calcium and thereby becomes free paracasein, which is insoluble in brine solution.

We believe that, according to the evidence in hand, the following equation represents the reaction which takes place where the compound in question is taken into solution by a salt solution:

$$\text{Calcium caseinate} + 2\ NaCl \rightleftarrows \text{Sodium caseinate} + CaCl_2.$$

We believe that the mass action, thus represented, is also connected with the precipitation produced upon adding calcium chloride to the brine-soluble compound after its solution has been freed from excess of chlorides by dialysis.

The Influence of Sodium Chloride on the Precipitability of Casein by Acetic Acid, and its bearing on the Partition of Nitrogen in Butter: Wm. N. Berg.

The Estimation of Creatin: Stanley R. Benedict.

Twenty c.c. of urine (or a volume equal to twice the amount which will be required for an accurate creatinine reading) is treated with 20 c.c. of approximately normal hydrochloric acid and the mixture boiled nearly to dryness in a beaker or open flask. After the mixture has almost reached dryness it is placed in a boiling water-bath, and allowed to remain there for about five minutes after the residue is approximately dry. With the aid of warm water the residue is then washed into a fifty c.c. volumetric flask, the mixture cooled and five c.c. of 8–10 per cent. basic lead acetate solution added, and the mixture diluted to exactly fifty c.c., and mixed by shaking. The mixture is filtered through a dry filter into a dry beaker and twenty-five c.c. of the filtrate used for the colorimetric determination as in Folin's process, save that six c.c. 10 per cent. alkali are

employed, which should best contain also five per cent. of rochelle salt. This process has the great advantage that in the conversion of the creatin less pigment is produced than in former methods.

The Determination of Calcium in the Presence of Phosphates and Magnesium: F. H. McCRUDDEN.

Methods of Estimating Moisture in Tissues: WALDEMAR KOCH.

With valuable biological material it is sometimes desirable to make water estimations and the estimations of the other constituents on the same sample. As there is danger of decomposing the constituents by the high temperature employed for drying in the official method, comparisons of this method with the one devised some years ago[2] and used in this laboratory were made and are recorded in the following table:

	W. 8 Direct with Alcohol	W. 21 Dried by Heat at 95° C.
Proteins	48.5	47.5
Phosphatids	21.6	16.3
Cerebrosides	8.8	9.4[3]
Sulphatids	3.6	4.3[3]
Undetermined lipoids	8.2	11.0[4]
Organic and inorganic extractives	9.3	11.6
	100.0	100.1
Lip P in per cent. of total	62.5	53.6

The Preparation of Tissue for Toxicological Examination: JAMES P. ATKINSON.

The finely minced tissue is digested with artificial gastric juice. The solution is filtered and extracted for alkaloids in the usual way. After this extraction the material is evaporated with nitric acid and then examined for metallic poisons. This method has three advantages: (1) The examination may be completed within three days, (2) less personal attention is required, (3) the tissue is completely broken down and therefore allows a better extraction of the alkaloids than by extracting the minced tissue with acid alcohol.

Studies of Water Absorption by Colloids: WILLIAM J. GIES.

On the Diffusibility of Biological Substances through Rubber: WILLIAM J. GIES.

[2] W. Koch, *The Journal of the American Chemical Society*, Vol. XXXI., p. 1335.

[3] Variation due to difference of age.

[4] Increase due to fatty acids from destruction of phosphatids.

The Aging of Flour and its Effect on Digestion: J. A. WESENER and GEO. L. TELLER.

The Occurrence of Lipase in the Fat of the Common Fowl (Gallus domesticus): M. E. PENNINGTON and J. S. HEPBURN.

If a chicken be kept hard frozen or at the temperature of the room, or at any temperature between these two extremes, the acidity of the fat increases, as has been shown in previous publications of this laboratory. Since the fat-splitting enzyme, lipase, is found in many plant and animal tissues, this investigation was undertaken to determine if lipase be present in the crude fat of chickens. The technique is fairly simple. The crude abdominal fat is passed several times through a meat chopper; and its acidity is determined. A weighed sample of the ground fat is triturated in a mortar with sand, and then extracted with ten times its weight of water. Fifty c.c. of the aqueous extract and 1 c.c. of an ester (ethyl acetate, butyrate or benzoate, or amyl salicylate) are mixed, the solution is made neutral to phenolphthalein and incubated at 40° C. for periods of time varying between 24 and 168 hours—usually 72 hours. Toluol is used as a bactericide. Fifty c.c. samples of the aqueous extract are boiled, then run as blank experiments in exactly the same manner as were the determinations proper. At the end of the incubation both determinations and blank experiments are titrated; the increase in acidity of the determination proper over the blank is due to the action of lipase.

This research has demonstrated the presence of lipase in the crude abdominal fat of fresh chickens retaining the animal heat, and of chickens kept at temperatures from that of the room to that of the "freezer" for varying periods of time. The highest acidity of the crude fat, and the greatest activity of the lipase, occurred in chickens which had been kept hard frozen for sixteen months, or which had been permitted to putrefy at room temperature. The lowest acidity of the crude fat and the least activity of the lipase were found in a fresh chicken still retaining the animal heat. Apparently in fresh birds the enzyme is present as a zymogen, which is converted into the active form as the chicken ages after death.

Deterioration in Eggs as shown by Changes in the Moisture Content: A. D. GREENLEE.

Eggs contain a high percentage of moisture when fresh—white about 88 per cent. and yolk about 48 per cent. This percentage of moisture is constantly changing, due both to a loss to the

external atmosphere by evaporation and also to internal rearrangement. The yolk absorbs water from the white. This change increases with the temperature and time, and when carefully measured it becomes a good index of the condition and probable age of the egg. By test experiments on a uniform lot of eggs, held at a constant temperature and analyzed at short intervals of time, the rate of change of moisture content can be determined and plotted and by means of the subsequent formula derived, the condition of any lot of eggs can be predicted from the first analysis for any given date within the holding period.

By a further extension of the work now in progress it is hoped that the age and past history of the egg can be deciphered from a determination of the percentage and relative distribution of the moisture.

The Oxidation of Chicken Fat with Hydrogen Peroxide: J. S. HEPBURN.

When light, air, heat and enzymes act on fats and oils, the various constants undergo changes; and an increase in saponification number is usually accompanied by a decrease in Hehner number, and *vice versa*. This phenomenon is due chiefly to the oxidation of the unsaturated acids at the double bonds. However, when chickens are kept hard frozen, both the saponification number and the Hehner number experience simultaneous change in the same direction. Thus nine analyses give a mean saponification number 172.9 and a mean Hehner number 81.27 for fresh roasters, while three analyses of undrawn roasters, kept hard frozen for 16 months, give a mean saponification number 194.9 and a mean Hehner number 91.67; the two constants have increased at the same time. This species of fat decomposition must be due to oxidation of the carbon chain at or near the terminal carbon atoms. The recent work of Dakin upon the oxidation of saturated fatty acids by means of hydrogen peroxide, led to the present research.

Fat was extracted from chickens and analyzed. The extracted fat was heated on the water-bath for seven hours with three per cent. solution of hydrogen peroxide—six molecules of peroxide were used for each molecule of fat; the fat was then separated from the aqueous layer, washed free from peroxide with boiling water, filtered through paper and analyzed. The acidity always became higher; the iodine number usually decreased, though it occasionally increased. The saponification number and the Hehner number almost invariably increased simultaneously, hence dilute hydrogen peroxide at the temperature of the water-bath produces in chicken fat the same change as occurs in that fat *in situ* while hard frozen.

When oleic acid and stearic acid were oxidized in this manner, their saponification number decreased. This change is similar to that undergone by the fat of chickens kept hard frozen for periods of four months, at the end of which time both the saponification number and the Hehner number are lower than in the fat of fresh birds.

Detection and Rôle played by Polyatomic Phenols occurring in Apples as Glucosides: H. P. BASSETT.

In apples there is a glucoside resembling phloridzin. There is present also an enzyme which hydrolyzes it, liberating a polyatomic phenole. From the phenole by the action of an oxidizing enzyme a phlobaphene is formed. This oxidase reaction renders the fluid germicidal. It is suggested that this has a protective value for the fruit.

Observations on the Deterioration of Maize and Improvements in the Methods of Detecting it: O. F. BLACK and C. L. ALSBERG.

An Incubator for Moderate Temperatures: A. M. BUSWELL and RALPH H. MCKEE.

The incubator uses, without the aid of a relay, a 110-volt alternating current for the heating and the regulation of the current. The expanding liquid of the regulator is alcohol, the capillary U-tube outlet being filled with mercury. Five wires are sealed into the capillary tube and the resistances attached so that the voltage drop, as the mercury passes a sealed-in wire, will be but twenty volts. This is below the arcing voltage and consequently no carbonization occurs and practically no gas is formed by the make and break. The lights used for heating are in series with the mercury and such resistances as are pushed in by the expanding alcohol. Without attention the incubator kept between 36.5° and 37.5° for two months.

The Absorption of Inorganic Salts by Living Protoplasm: W. J. V. OSTERHOUT.

Carbohydrate Esters of the Higher Fatty Acids: WALTER R. BLOOR.

Esters of mannitol with stearic acid were prepared and their properties described. One of them was fed to animals. It was found that about 50 per cent. was absorbed.

(To be continued)

SCIENCE

FRIDAY, AUGUST 25, 1911

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE CALCULUS IN TECHNICAL LITERATURE

IT would be difficult to get a majority report on either the quantity or quality of the calculus used by practising engineers in any country even if their individual opinions on the matter could be obtained. Evidences of the many conflicting views likely to be held are presented in the testimony along this line contributed by former students of ours who, after a brief experience in the technical world, give us their impressions of how much they have been called upon in actual practise to use the various mathematical principles with which they wrestled so laboriously in freshman and sophomore college days.

Instructors of mathematics in universities where sections of engineering majors are formed have, no doubt, heard recited, as I have, the many and varied experiences of these young engineers with the problems involving mathematics which arose at various times in their brief experience. Perhaps some cub engineer, who already had done a piece or two of engineering work worth while, has told you of how he has never yet had to use his calculus and that he wonders why we keep on teaching it. Perhaps you have been told, as I have, that if the prospective engineers are thoroughly grounded in the differentiation and integration of u^n, and know what they mean and how to use them, they will then have as much calculus as they are likely to use in the problems which may arise. Again, you may have heard another say, as I have, that he is already using all the mathematics he ever learned—and then some—and that he wished he had taken various

other advanced courses in mathematics while in college.

The problems sent on by the young men in practise, and referred to you acting as a sort of consulting engineer, may vary, as I have experienced it, from those in which in the solutions sent an error was made in using the common logarithm of a number instead of the natural to those where the principles of the calculus involved were beyond what they had had time to study while in college. The problems were always live ones, definitely stated, and the solutions simply must be obtained—if not exactly then at least approximately correct. When they needed their calculus they needed it right away—of course they were going to get the result some way.

On the other hand, I have heard a professor of a technical subject in an engineering school of merit say in substance that perhaps, after all, calculus ought to be regarded as a culture subject; that it afforded good mental discipline, but that he doubted its value as a tool in engineering practise.

However much the opinions expressed may have varied, it has always seemed to me that the further a practising engineer advanced in his profession the more respect did he show for the elegant processes of not only the calculus but also of mathematics in general. These men may not themselves be called upon to work out the details of a design involving perhaps principles of the calculus, yet they will be competent in checking to pass on designs executed by others. They will also have a wide acquaintance with technical literature, especially that bearing on their special field.

When the mathematicians and engineers met in a joint conference at Chicago to investigate further the subject of mathematics for engineering students there seemed to be no question whatever as to the desirability of a thorough knowledge of the calculus, with the ability to use it, on the part of the engineer; the question simply was one of quantity, quality and efficiency in mastering the same.

The practising engineers, and I am speaking of those who have attained a position of at least average merit, keep in touch with modern developments not only in this country but in others as well, just as far as their knowledge of foreign languages will allow them to follow the literature. Assistants in large libraries will tell you that files of the current foreign technical papers, which may have been neglected entirely in undergraduate days, are later eagerly read by men of affairs who seemed to know what they were after.

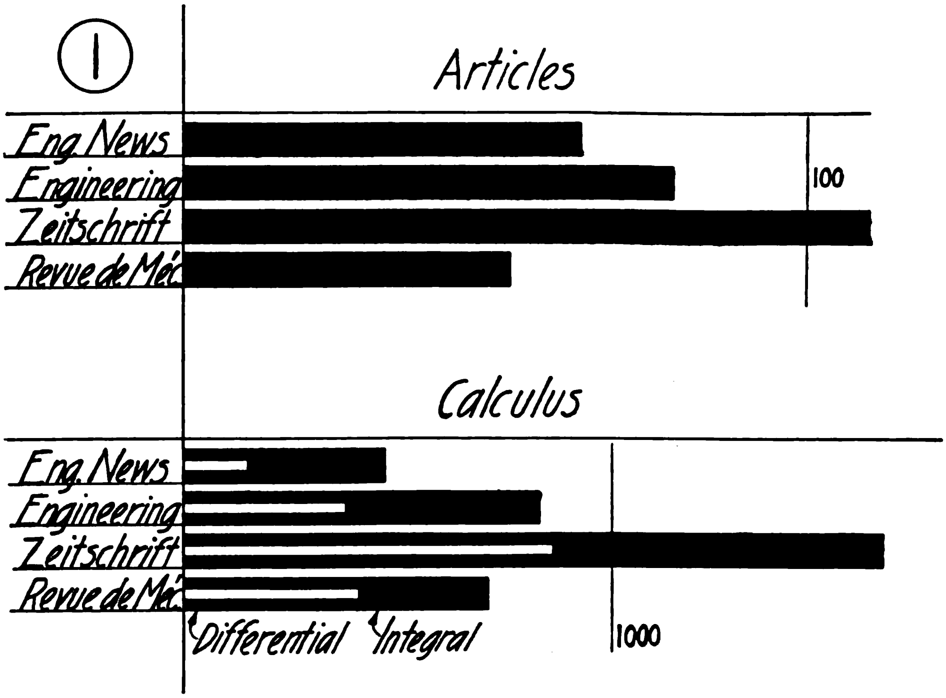
While not every advance in technical lines is reported in the journals, yet it would be safe to say that the most of those possessing merit receive recognition in publication, and that the files of a journal for a period of years are apt to reflect quite accurately the thoughts and deeds of engineers in the particular field covered by the journal in question. The aims and interests of engineers are clearly reflected—perhaps we may even get their attitude toward the calculus. And I would rather judge by what is done than what is said —an engineer early learns the value of results.

Different engineers will use and be interested in different fields of mathematics. Some editors of technical journals wouldn't care to publish an article heavy because of the mathematics used, and yet all use mathematics more or less—because they must. The question then arises as to the journal in any country chosen as the reflector of the opinions of engineers on the mathematics used and read during a period of years.

I have chosen the following journals as:

representative in their respective countries: America, *Engineering News;* England, *Engineering;* Germany, *Zeitschrift des Vereins Ingenieur;* France, *Revue de Mécanique.* The first three papers are published weekly, the last monthly.

To get at the principles of the calculus used, and to what extent, I read the articles in the above journals making use of the principles of the calculus, published during the five years 1905–1909. The articles in which the calculus was used were listed and the results shown in Fig. 1. Many articles contained a species of "near calculus," thus making the question of including it or not doubtful; final disposition of the case was made on the basis of the article including at least one principle of the calculus and employing its nomenclature. The authors of the articles made use of the principles as needed, and understandingly. To read the articles intelligently a knowledge of the fundamental principles of the calculus was necessary—on this basis were the articles and principles listed.



The contributors of these articles included all classes of practising engineers, army officers, government officials, consulting engineers, whether connected with technical institutions or not, and professors in technical schools and universities. That the articles were read by engineers is evidenced by the numerous comments on the same sent in to the editors, as well as by the records of assistants in libraries specializing in files of technical papers.

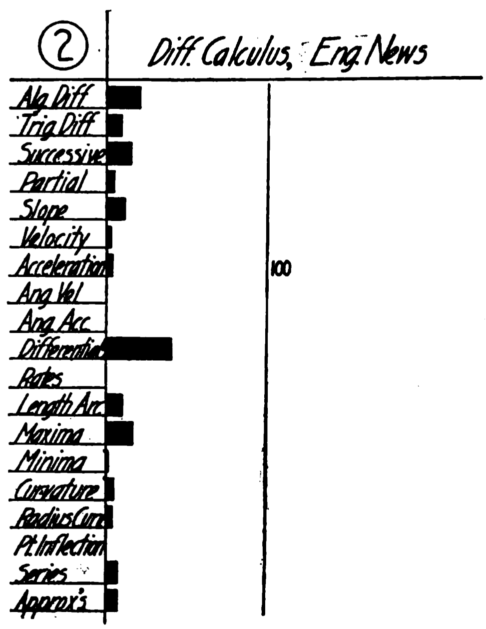
I do not use as a basis the opinions of men as expressed in the journals but rather investigated the principles actually used. The opinions of engineers, as expressed in the journals, were found to vary as much as the oral reports made by the young engineers formerly mentioned, and along this

line we find, quoting from the four journals chosen, such expressions as "formidable mathematics," "mathematical rubbish"; one writer apologizes for his "mathematical fireworks"; another says of a writer that he "enveloped elementary principles of engineering theory in such a haze as to render pursuit hopeless to any but a confirmed mathematician." Again, speaking of the work of young college graduates, one writer said: "All of them did calculating without checking as they proceeded," and "Accuracy is one of the keys to success."

From another paper we quote: "It is the pride of mathematicians to compress a great deal into a single formula. But a diet of tabloids, however full of nourishment, is not adapted to all digestions; and the present paper goes to the other extreme—namely, spoon-feeding." Again we quote: ". . . great respect for mathematical proofs—if experimental results don't support the theory so much the worse for experimental results."

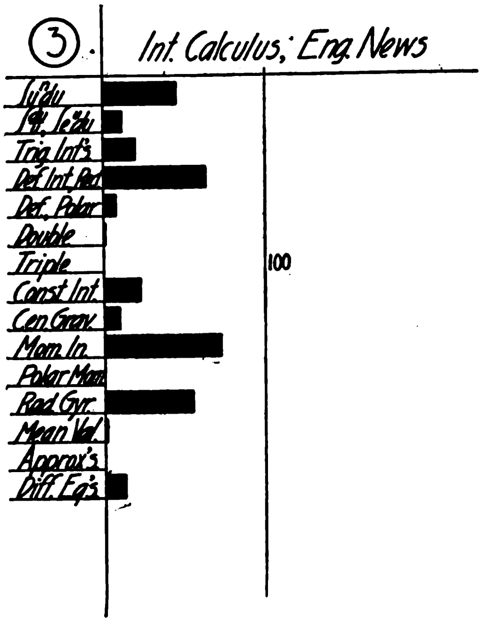
In a third journal we find a writer openly stating that he is writing his article so that the engineer knowing very little calculus, especially the integral, may yet read his article. Many other opinions expressed could be cited, and much discussion back and forth concerning proper methods of instruction in engineering mathematics abstracted with profit; yet it seems to me that, after all is said and the smoke of battle has cleared away, the engineers would, or should, rather be judged by what they do, and hence I present in the following table, I., a summary of the number of times which it seemed to me the calculus was used in each of the papers mentioned above during the period 1905–1909. The figure will explain itself when it is suggested that as far as a quantitative result is concerned I listed each principle of the differential and integral calculus as it was used in an article. It might easily be that, with a viewpoint different from the one used, that the table as made out by another might look entirely different from a quantitative standpoint, yet relatively the results could not differ materially. Different principles, as applied, might be listed numerically differently by two men working out the same problem. In listing these principles I counted a single one only once during a discussion, even though the same expression may have been used many times. However, when the same principle was used in a new form, or a new application made, it was again counted.

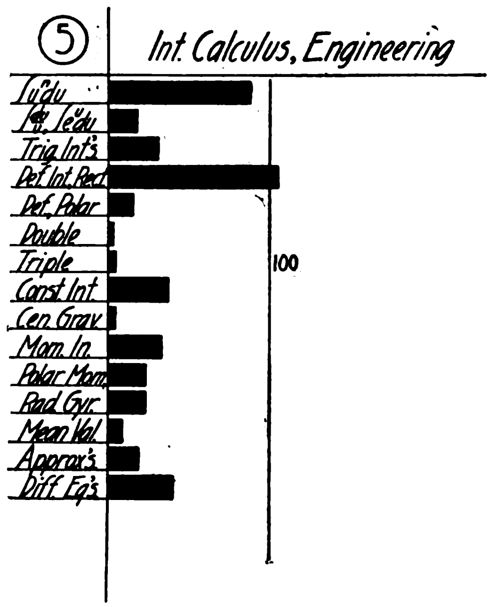
Regardless of opinions expressed in the journals and on the basis of the use made of the principles of the calculus in the years 1905–1909 we present Figs. 2 to 9 as giving the relative importance placed on these separate principles by the journals named. It may be said that each was used with the idea in mind that the reader was acquainted with all of them, and even

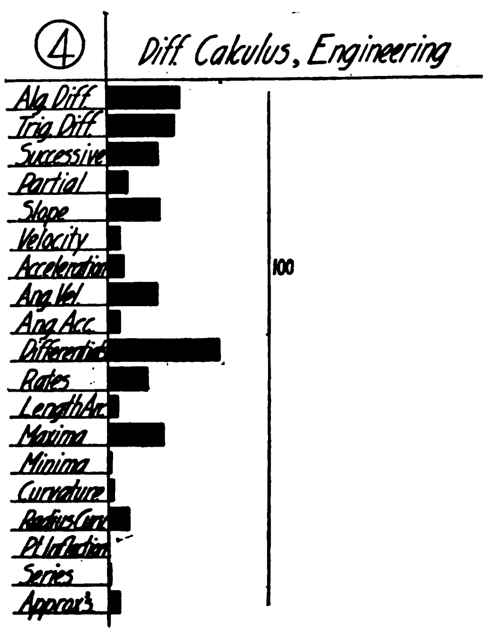


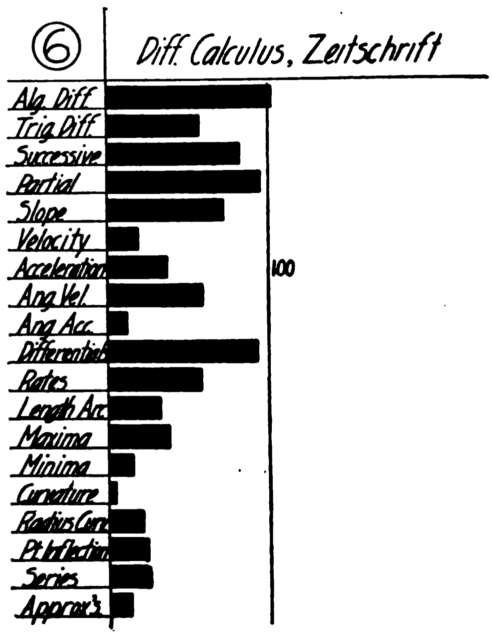
when an elliptic integral, a differential equation, or a Fourier series was used it was assumed that the reader was familiar with such.

The results as shown in the figures will, on comparison with similar figures accompanying an article in Science, October 22, 1909, in which a study of the calculus in

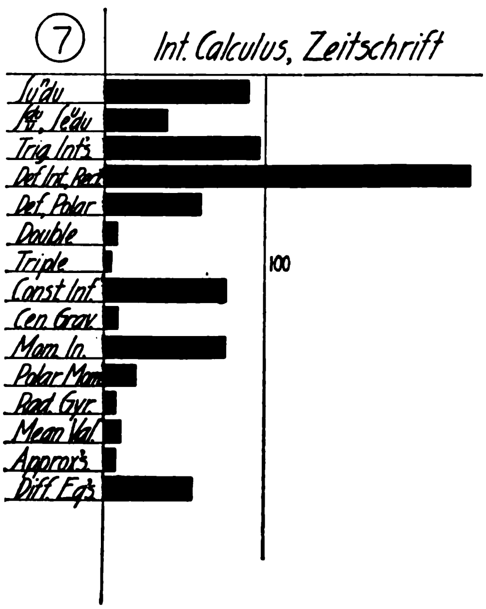






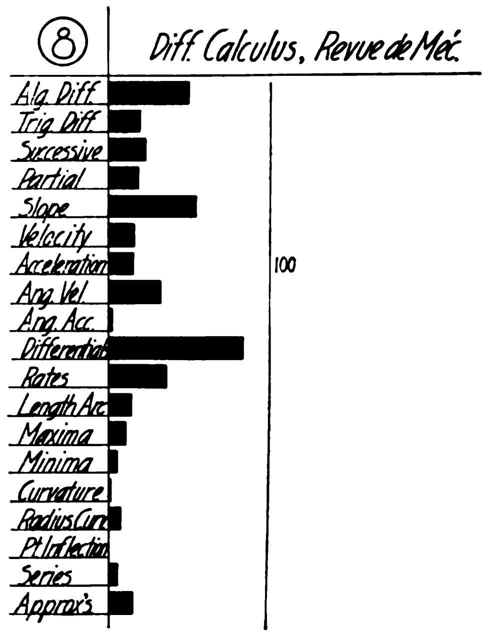


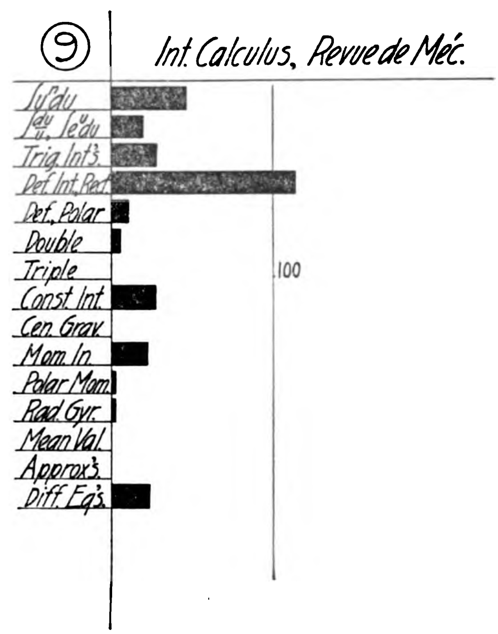
undergraduate technical courses was made, be found to agree closely with those published formerly in the relative emphasis placed on the various principles. Again we find that, for instance, the formulation of the definite integral and its interpretation by means of an area drawn to scale, stands out most prominently. This fundamental principle is just beginning to receive the recognition due it in the teaching of the calculus to engineering students, and deserves all the emphasis it receives in the Preliminary Report of the Committee



on the Teaching of Mathematics to Students of Engineering recently issued, and in several of the elementary texts on calculus recently published.

On the other hand, the results of the present investigation confirm the writer in his former belief that the subject of indeterminate forms and their evaluation has in it from a practical standpoint little of value for the engineer. There were found just two distinct cases where such forms arose and where methods of the calculus were used to evaluate the same. In view of the fact that such forms occur rarely in





engineering practise and that the required limit of each can generally be obtained

after transformation it is doubtful from the standpoint of the engineer if the subject is worth over a page of discussion in the report referred to above, or the many pages—in one case as many as 18—of recent elementary texts on the calculus. The time given to them in the course on calculus could be used to much better advantage elsewhere.

The relatively few times that the double and triple integrals are used agrees with the results in the undergraduate discussion. Double and triple integrals could be used more, but they aren't; engineers seem to prefer the single integral. From this we would not argue that they should receive attention in a course in the same ratio as they are found used in practise, for both have greater merit and occasions do arise in which they are fundamentally necessary and important.

The differentiations and integrations, as shown, are, for the most part, limited to a few types and are generally readily executed. The algebraic integrations do not at all resemble the heavy forms involving radicals and reduction formulas which were so painfully evident in the college course in calculus. The trigonometric forms, both in differentiation and integration, are limited almost entirely to sines and cosines and their combinations. The heavier integrations, both algebraic and trigonometric, are apt to occur in connection with the solution of the differential equations arising in the discussions.

Partial differentiation comes in for considerable attention partly because of the fact that the journals listed, especially the foreign, always seemed to welcome an article making use of the principles of thermodynamics. The relative importance of this portion of the calculus to the engineer seems to be greater than would be indicated by the amount of time given the subject in most of the courses in calculus for engineers.

The principles of angular velocity and acceleration are used with considerable frequency in the foreign journals, thus indicating clearly the strong influence of the mechanical engineering side of the technical field.

The attitude of all the journals in the matter of symbols is the same and agrees with the almost universal custom among mathematicians in this country. The somewhat forced efforts made for some time by certain mathematicians in this country to introduce capital letters in connection with derivatives seems to have received no recognition whatever among engineers.

Whenever a differential is used it has a strong resemblance to the infinitesimal of the mathematician, or perhaps a rate, where the time element comes in; but it will be noticed early that the processes of the engineer, by nature correct to, say, so many decimal places are not always the processes of the mathematician confirmed in his use of the limit. Increments sometimes take the place of these differentials and very neat bits of theory are carried out by their use—a "near calculus" as it were. It is at times difficult to distinguish between the use of Δx and dx and yet the idea of the limit is there all the time. Rigor within the limit of allowable error is the key-note throughout. As an illustration I quote: "Let the radii of curvature of the surfaces where the oil film is infinitely thin be r_1 and r_2; then, since we are dealing with films of capillary thickness, we may treat the dimensions as infinitesimals as compared with r_1 and r_2." With which many a pure mathematician will find it difficult to agree. And yet the proofs do not break down at any point.

More maxima and minima are found directly from the study of algebraic and

trigonometric expressions than by the methods of the calculus, and but little attention is paid to the sign of the second derivative in determining the nature of the same. The conditions of the problem are, in general, sufficient to determine the nature of the result on solving the equation obtained by putting $dy/dx = 0$.

Series where used are assumed to be convergent, or at least their convergence is not questioned. They are generally simple types.

Many approximations occur in engineering practise, while those listed seem to be few in number. However, none was counted except the approximations of the calculus. Among such we might mention $1/r = d^2y/dx^2$, which is used in a case where, as stated, "dy/dx is small."

The symbol of summation Σ is used often and we find many a case of "near integration." The great importance placed on the formulation and evaluation of the definite integral is everywhere evident and many areas are found where no definite integral is expressed and where it is absolutely essential to keep in mind the relation between the two. In this connection we wish to mention the universal use of indicator diagrams, and the frequent mention of the planimeter used in determining areas approximately—a point of view which should be kept in mind when the subject of definite integrals is being considered in the class-room.

In connection with the integrations found it seemed that at times the constants multiplying the integral were by far the most important part of the expression. Instructors of calculus might with profit at times allow their students to make their own choice of such constants, which should be placed on the outside of the integral sign before evaluating the definite integral. The term moment of inertia seems to mean two things to two different classes of engineers. The engineer dealing with static problems will have almost exclusively to do with moments of inertia of sections, while one working with problems bringing in dynamics will think of what in one case is called the "equatorial moment." The two points of view should receive equal attention in any course on the calculus.

Concerning the differential equations used and their solutions it may be said that those used were of the simpler types usually included in an elementary treatise on ordinary differential equations. However, it seems to me that their solutions must at times have been far above the head of the average engineer, unless he had given the subject special attention after completing his university course in engineering. The recommendation of the committee on engineering mathematics is to the point, and should be carefully considered by the instructor of calculus. It agrees with results as found in practise.

A further study of the mathematics used by the practising engineer will reveal other conditions in every way similar to those existing in the undergraduate technical course. The algebra and trigonometry used are heavy as compared with the calculus; naturally they are used much oftener.

If we look for things characteristic of the engineer we easily find that numerical results, correct to a certain decimal place, are common and that much stress is placed on accurate computation. Much care is bestowed on the drawings and illustrations, and constant attention is given to the scale of the same. This is necessary in checking up. Much use is made of indicator diagrams and the planimeter is used to obtain or check up on areas. At least one of the journals makes a considerable use of the first and second derivative curves and

their interpretation. The policy of the *Zeitschrift* in using such curves is to be recommended to the instructor when the subjects of velocities and accelerations are under consideration.

A common practise in approximating is that of using small angles, their sines, and tangents synonymously.

The checking up process stands out prominently; not only do the engineers say they believe in it but they also practise it as well. Instructors of mathematics may easily learn a lesson here.

The definite character of the results is evident; the authors get down to fundamental principles, remain clear throughout a discussion, and finish with concrete results.

Here and there is found an article on a special subject which will tax the mathematical capacity of most engineers, perhaps be far above their heads. Such are generally contributed by professors in universities and mark the limit of the mathematical field for engineers. We find a rare use of an elliptic integral, a Fourier series, homogeneous coordinates, partial differential equations, and the fundamental principles of the calculus of variation. However, these are rare and the articles using such will be read by but a very limited number of engineers.

A comparison of the articles in the different journals will show for the American the strong preponderance of the civil engineering, while the foreign journals lean more to the mechanical engineering side. In none of them do the articles go into the details of the projects in electrical engineering. The articles in this latter field are mostly of a descriptive nature, in which electric power installations, machines and appliances are discussed. Whenever mathematics is used in the electrical engineering field it verges on the more "formidable" mathematics of mathematical physics, combined with a liberal sprinkling of the complex variable and differential equations. The list examined can hardly be said to contain a journal specializing in the field of electrical engineering. However, if the stronger journals in the electrical field be examined they will be found to strongly emphasize the descriptive features of the field; and a conclusion which may be drawn from this fact is that even the rudiments of research and design in that field would immediately involve mathematics in the principles of which the average engineering major has had but little training. Articles going into these details would not be read as the more general articles in the other fields of engineering are read.

The technical literature also reflects the highly developed scientific spirit of Germany, which has permeated into all the branches of its technology. The continental journals, especially the German, start with fundamental engineering principles and make a liberal use of the calculus and other branches of mathematics; so that when a discussion is completed it is evident that a piece of work worth while has been thoroughly done. On the other hand, the American attitude of wanting to get things done in short order is also plainly evident; the American engineer will generally not take the time to work out a bit of theory in the details of which the German engineer will revel. He will use—and with a full significance of their purpose—the results laboriously obtained by others, thus specializing on the applications. A formula developed with much care from fundamental principles by his foreign brother will appeal to an American engineer as something which should immediately be put to practical use.

The English journals take as much pride in the design of their battleships and ves-

sels of commerce as the Germans and French in their air-ships and the Americans in their sky-scrapers. And all are interested in turbines. The *Zeitschrift* seems to be by far the greatest source of scientific advances in technology, and the engineering journals of other nations look to it as the dean of them all.

A study of this sort would not be complete unless it took into consideration the far-reaching effect which the failure of the Quebec bridge, on August 29, 1907, had on technical literature, especially in America. In the many discussions of column formulas resulting, with special reference to the value of l/r found in most of them, we can easily see the strong inclination of the American engineer toward a plausible formula. Many discussions followed the disaster, most of them making use of l/r and suggesting modifications of the column formulas in existence. It may be questioned, in view of the results of recent tests made on built-up columns, whether the old formulas, even with modifications, will not be superseded by some entirely new rules for the design of such columns.

It may be stated, in conclusion, that the attitude of the engineers toward the efficient teaching of the principles of mathematics, as gathered from their discussions, is sane and their interest great. Naturally, they call for results and are apt to be impatient if a college graduate violates fundamental principles which should have been thoroughly mastered long before. They are aware of the difficulties encountered in the efficient teaching of mathematics and of the different viewpoints of instructors of mathematics. On the other hand, instructors of mathematics for students of engineering should maintain an attitude of sympathy with the problems of the engineer, or at least recognize and become acquainted with them. That both engineers and mathematicians are working more and more toward a common end, and with a better understanding of the problems involved, is evidenced by the results of the many joint conferences held recently for the purpose of securing that greater efficiency, which is the watchword of the age.

Ernest W. Ponzer
Stanford University

RICHARD KLEBS

Professor Dr. Richard Klebs, geologist and knight of high degree, connected with the Royal Geological Survey, and scientific adviser to the Royal Amber Works, died in Konigsberg, Prussia, on June 20, 1911, in his sixty-seventh year.

Dr. Klebs was well known throughout the world for many papers on the subject of amber and its industry, the inclusions and the study of the coleoptera, and plant and insect inclusions in amber masses, he himself gathering and owning the great collection which was exhibited under the auspices of the Imperial German government at the St. Louis Exposition in 1904. This great collection consists of 10,000 inclusions in amber, including beetles, fleas, spiders, wood, leaves and many other interesting objects associated with the history of amber. It is valued at $40,000 and will only be sold as an entirety.

The last paper he wrote, and of which he sent me a reprint, is entitled: "Ueber Bernsteineinschlusse im allgemeinen und die Coleopteren meiner Bernsteinsammlung," with text illustrations, which appeared in the "Schriften der Physik.-okonom. Gesellschaft zu Konigsberg i Pr." Jahr. LI., pp. 217–242, III., 1910. Dr. Alfons Dampf, assistant in the Konigl. Zoologischen Museum, Konigsberg, described a fossil flea occurring in Baltic amber and named it "Palæopsylla klebsiana," in honor of his friend, Dr. Klebs (pp. 248–259, pl. 2, 1910–11).

Dr. Klebs possessed an earnest, cheerful personality; was an indefatigable worker, published many papers on his subject, and suc-

ceeded to a far greater extent than any one else interested in attracting notice to the great amber industry, which the German government is now paternally fostering with much satisfaction to all and with considerable financial success. He leaves a wife, a brother and grandchildren—one a son-in-law of Dr. Carl Kaiserling, of the University of Berlin.

GEORGE F. KUNZ

THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS

ANNOUNCEMENT is made by Dr. H. W. Wiley, secretary of the Association of Official Agricultural Chemists, that the twenty-eighth annual convention of the association will be held at Washington, D. C., from November 20 to 22. The program is as follows:

MONDAY, NOVEMBER 20

MORNING SESSION

Phosphoric Acid: H. D. Haskins, Amherst, Mass.

Determination of Nitrogen: J. W. Kellogg, Harrisburg, Pa.

Potash—

Determination: E. L. Baker, Geneva, N. Y.

Availability: H. H. Hill, Blacksburg, Va.

Soils: J. G. Lipman, New Brunswick, N. J.

Inorganic Plant Constituents: O. M. Shedd, Lexington, Ky.

AFTERNOON SESSION

Appointment of Committees

Insecticides: C. C. McDonnell, Washington, D. C.

Water: W. W. Skinner, Washington, D. C.

Committee A on Recommendations of Referees: J. P. Street, New Haven, Conn.

Reports of Special Committees

Amendments to the Constitution: L. L. Van Slyke, Geneva, N. Y.

Appropriation: J. P. Street, New Haven, Conn.

Availability of Phosphoric Acid in Basic Slag: W. F. Hand, Agricultural College, Miss.

Cooperation with other Agricultural Organizations: H. W. Wiley, Washington, D. C.

Food Standards: William Frear, State College, Pa.

Journal of Agricultural Research: W. A. Withers, Raleigh, N. C.

Participation in the Eighth International Congress of Applied Chemistry: J. P. Street, New Haven, Conn.

Presentation of the Question of Unification of Terms to the International Congress of Applied Chemistry: R. J. Davidson, Blacksburg, Va.

Standardization of Alcohol Tables: L. M. Tolman, Washington, D. C.

Testing of Chemical Reagents: L. F. Kebler: Washington, D. C.

Unification of Methods of Analysis of Fats and Oils: L. M. Tolman, Washington, D. C.

TUESDAY, NOVEMBER 21

MORNING SESSION

Food Adulteration: A. S. Mitchell, St. Paul, Minn.

Colors: W. E. Mathewson, New York City.

Saccharine Products: S. H. Ross, Omaha, Neb.

Fruit Products: A. W. Blair, Gainesville, Fla.

Wine: E. J. Lea, Berkeley, Cal.

Beer: W. D. McAbee, Indianapolis, Ind.

Distilled Liquors: J. O. LaBach, Lexington, Ky.

Vinegar: W. A. Bender, New York City.

Flavoring Extracts: R. S. Hiltner, Denver, Colo.

Spices: R. W. Hilts, Philadelphia, Pa.

Baking Powder: E. W. Magruder, Richmond, Va.

Meat and Fish: Ralph Hoagland, St. Anthony Park, St. Paul, Minn.

Fats and Oils: H. S. Bailey, Washington, D. C.

Dairy Products: A. E. Paul, Chicago, Ill.

Cereal Products: H. L. White, Agricultural College, N. D.

Vegetables: J. P. Street, New Haven, Conn.

Condiments other than Spices: W J McGee, New Orleans, La.

Cocoa and Cocoa Products: W. L. Dubois, Buffalo, N. Y.

Tea and Coffee: M. E. Jaffa, Berkeley, Cal.

Preservatives: H. E. Barnard, Indianapolis, Ind.

Water in Foods: H. C. Lythgoe, Boston, Mass.

Organic and Inorganic Phosphorus in Foods: H. S. Grindley, Urbana, Ill.

President's Address (special order for 12 o'clock).

AFTERNOON SESSION

Separation of Nitrogenous Bodies—

Meat Proteids: C. R. Moulton, Columbia, Mo.

Milk and Cheese: A. W. Bosworth, Geneva, N. Y.

Vegetable Proteids: R. Harcourt, Guelph, Canada.

Committee C on Recommendations of Referees: A. L. Winton, Chicago, Ill.

WEDNESDAY, NOVEMBER 22

MORNING SESSION

Dairy Products: G. W. Cavanaugh, Ithaca, N. Y.
Foods and Feeding Stuffs: G. M. MacNider, Raleigh, N. C.
Sugar: W. E. Cross, New Orleans, La.
Committee B on Recommendations of Referees: E. M. Chace, Washington, D. C.
Reports of Committees (resolutions, nominations, etc.): J. S. Rogers, Washington, D. C.

AFTERNOON SESSION

Medicinal Plants and Drugs: L. F. Kebler, Washington, D. C.
  Medicinal Plants: Albert Schneider, San Francisco, Cal., and H. H. Rusby, New York City.
  Synthetic Products: W. O. Emery, Washington, D. C.
  Medicated Soft Drinks: H. C. Fuller, Washington, D. C.

Special papers closely connected with the work of the association, and not exceeding 10 minutes in length, will be given place on the program if the titles are sent to the secretary ten days before the meeting.

SCIENTIFIC NOTES AND NEWS

DR. GILMAN A. DREW, since 1900 professor of biology at the University of Maine, and since 1909 assistant director of the Marine Biological Laboratory, has been appointed resident assistant director of the laboratory, and will devote his entire time to the work at Woods Hole.

IN the Geodetic Institute of Potsdam, Professor Andreas Galle has been appointed chief of department, and Dr. Wilhelm Schweydar, observer.

THE fifteenth anniversary of the doctorate of Dr. Wilhelm Waldeyer was celebrated on July 22. The Prussian minister of education and the Prussian war office presented him with gold medals, Dr. Hans Virchow with a Festschrift, and Dr. Paul Ehrlich with a volume of his own.

DR. WOLDEMAR VOIGT, professor of physics at Göttingen, has been elected a member of the Paris Academy of Sciences.

THE first award of the Dr. Jessie Macgregor memorial prize has been made to Agnes Ellen Porter, M.D. Edin. The prize has been awarded to Dr. Porter for work done in the last three years, mainly in the departments of bacteriology and physiology, and especially for her work on the precipitative reaction in tuberculosis.

PRESIDENT TAFT, Mr. John Hays Hammond, Mr. James J. Hill and Mr. Walter Fisher, secretary of the interior, will be the principal speakers at the annual meeting of the American Mining Congress, to be held in Chicago on September 26, 27, 28 and 29.

THE Carnegie Peace Foundation Conference was opened at Berne on August 2 under the presidency of Professor Clark, of Columbia University.

PROFESSOR L. R. JONES, of the College of Agriculture of the University of Wisconsin, is engaged in the study of a new disease which affects the pea crop of this state and of a kind of black rot which attacks the cabbages.

PROFESSOR A. S. HITCHCOCK, systematic agrostologist, U. S. Department of Agriculture, has gone to Panama to join the Smithsonian expedition for the biological survey of the Panama Canal Zone. He has also been authorized by the Department of Agriculture to visit the five Central American Republics, for the purpose of investigating the grasses. He is accompanied by his son, Frank H. Hitchcock, as assistant.

PROFESSOR FRANKLIN H. KING, who was born in Wisconsin in 1848, died in his home at Madison, Wis., of heart failure, on August 4, aged sixty-three years. He was well known for his publications on agriculture, especially in connection with agricultural physics and the soil. Professor King was just about to publish a new work "Farms of Forty Centuries," containing an account of Chinese and Japanese farming as observed by him during a recent sojourn in the Orient. He was ably assisted by his cultured wife in the preparation of his publications, and she will doubtless be able to complete the editorial work on the forthcoming volume.

M. ERNEST MERCADIER, formerly professor of physics at the Ecole Superiéure de Télégraphic

and director of studies at the Ecole Polytechnique, Paris, died on July 27, in his seventy-sixth year.

A New York state civil service examination on September 16 will select men for the position of inspector of weights and measures and inspector of cold storage plants at salaries of $1,200.

President Taft has issued a proclamation setting aside as a national monument about 800 acres within the Sierra National Forest, known as the Devil Post-pile and Rainbow Falls.

We learn from *Nature* that among the bequests of M. Marino Corgialegno, a naturalized British subject, who died on April 26, are: £40,000 to institute a school at Athens on the lines of Eton or Harrow, "sharing in the desire expressed to me by his Majesty King George that education in Greece should be rendered more perfect by the establishment of a public or secondary school upon the model of the English public schools, where boys will receive a regular course of teaching as well as of good breeding"; £40,000 for a school for craftsmen at Argostoli, in the island of Cephalonia; £15,000 for technical scholarships; £10,000 each for a school for girls in Cephalonia, for schools or gymnasia in Argostoli, for a public library at Argostoli, for the Agricultural Society at Athens, for a polyclinical hospital in Athens, and for the Society for the Propagation of Useful Books.

The summer meeting of the Institution of Mechanical Engineers was held at Zurich and northern Switzerland, commencing on July 24. In addition to the meetings for the reading of papers, an extensive program of visits to works and hydro-electric power stations was arranged.

The fifth annual meeting of the Italian Society for the Advancement of Science, as we learn from *Nature*, will be held in Rome on October 12–18, under the presidency of Professor G. Ciamician. The sections of the association, with their presidents, are as follows: mathematics, astronomy and geodesy, Professor G. Castelnuovo and Professor A. Di Legge; physics, Professor P. Blaserna; applied mechanics and electrotechnics, Professor C. Ceradini; pure and applied chemistry, Professor E. Paternò; mineralogy and geology, Professor R. Meli; geography, Professor E. Millosevich; zoology, anatomy and anthropology, Professors G. B. Grassi, F. Todaro and G. Sergi; pure and applied botany, Professor R. Pirotta; physiology, Professor L. Luciani; pathology, Professors A. Bignami and E. Marchiafava; history and archeology, Professors G. Beloch and L. Pigorini; philology, Professor I. Guidi; social science, Professor M. Pantaleoni; philosophy, Professor P. Ragnisco. Several lectures on subjects of wide scientific interest will be delivered to general meetings of the association as a whole, and others to joint meetings of sections concerned with related subjects.

The report of the Pasteur Institute at Paris for the year 1910, which has recently been issued and is summarized in the *British Medical Journal*, shows a continuous decrease in the number of cases of rabies occurring or treated in France. In the year 1886 the number of persons bitten by rabid animals and treated at the Pasteur Institute was 2,671, and of these cases 25 were fatal, probably because treatment was too long delayed. In 1896 the number of patients treated had fallen to 1,308, with 4 fatal cases. Each subsequent year showed a steady decline in the number of cases of rabies, which numbered about 1,000 in 1902. In 1908 and 1909 the number of cases had fallen to 524 and 467 respectively, with 1 fatal case in each year; in 1910 the cases treated numbered 401, and for the first time since its foundation the Pasteur Institute was able to show a clean bill of mortality.

The United States and Canadian contributors to the eleventh edition of the Encyclopædia Britannica, presented to Hugh Chisholm, Esq., editor of the eleventh edition, a loving cup, properly inscribed, and on receiving it he writes as follows: "It will long be a matter of pride to myself and family to possess this memorial of American appreciation of my share in directing the cooperation of American scholars, men of letters, men of science and technologists in various departments,

in carrying out the ideal policy which was arrived at in planning the eleventh edition of the Encyclopædia Britannica, namely a combination of forces between the two great branches of the English speaking world. In the intellectual sphere it stands as a notable achievement of Anglo-American unity with which I am proud to have been associated. I thank the American contributors for their more than kind recognition of my labors towards that end."

A NEW research hospital, in which the committee for the study of special diseases will continue their researches on rheumatoid arthritis and allied diseases, is now in course of erection at Cambridge. The site, which has been presented by Miss Sykes at a cost of £300, has a southeast slope, with gravel soil, and the building has been designed with a view to simplicity and economy. As at present arranged provision is made for eight or nine patients, but should more accommodation be required double that number could be admitted. The funds available for the building now amount to a little over £1,000, and there is a sum of £800 still required in order to open the building free from debt. Dr. R. C. Brown, of Preston, who for the last four years has given a research scholarship of £150 a year, has during the past week signified his intention of continuing the scholarship for a further term of two years. The committee is at present making efforts to raise the remaining £800 required to complete the building and is also asking for subscriptions towards an endowment fund of £8,000. The executive committee are Sir Clifford Allbutt, regius professor of physic, Cambridge; Sir W. Selby Church, late president of the Royal College of Physicians; Sir William Osler, regius professor of physic, Oxford; Mr. T. S. P. Strangeways, Huddersfield lecturer in special pathology, Cambridge, and Professor Woodhead, professor of pathology, Cambridge.

THE first provisional announcement of the new course for public health officers, which is to be given for the first time during the coming year at the University of Wisconsin, has just been made. This course will be open to those who hold a degree in medicine or in medical or sanitary science and desire to fit themselves for public health work. The course extends through one year and leads to a diploma in public health. The work of the course is devoted largely to a study of bacteriology and practical field work in the use of disinfectants, the inspection of slaughter houses, schools, factories and work shops. Additional courses in physiology, zoology, meteorology, hydrology, public health administration and vital statistics, and the microscopic examination of foods and drugs will comprise the remainder of the work. The course in meteorology, or the study of weather conditions, is given for the purpose of determining to what extent the weather affects public health.

UNIVERSITY AND EDUCATIONAL NEWS

WORK is now being carried on to arrange and equip an entomology building at Rutgers College, New Brunswick, N. J. The building will have two stories, will provide for classrooms and laboratory work on the first floor and will furnish offices and space for collections on the second floor as well as accommodations for the assistants in experiment station work.

REAL ESTATE belonging to the Massachusetts Agricultural College to the value of $850,000 has been transferred to the state of Massachusetts in a deed recorded in Northampton. By this transfer the land and buildings of the college heretofore vested in the incorporated board of trustees passes under the direct control of the state.

THE Missouri College of Agriculture and Experiment Station is to have a regularly organized poultry department, the purpose of which is to investigate the various diseases and pests that affect farm fowls, to study the relative utility of different breeds of poultry for various localities of the state, to experiment with the problem of feeding poultry for breeding purposes and for market, besides giving regular courses of instruction in poultry husbandry to students.

OFFICIAL reports of the universities in Switzerland note that for the half year just finished, there were 10,311 students of which

1,322 were at the School of Technology. Of the 6,862 regular students of the seven universities, 1,490 were women. There were 459 in the department of theology, 1,354 in the law, 1,980 in medicine and 3,069 in letters or in sciences. The foreign element furnished 52.5 per cent. of the whole.

ALL the graduate work offered at the Ohio State University has been organized into a single graduate school under the administration of a dean and a graduate council of twelve members. Professor William McPherson, in charge of the department of chemistry, has been elected dean.

AT the Missouri College of Agriculture appointments have been made as follows: J. A. Ferguson, professor of forestry; A. J. Meyer, assistant to the dean and superintendent of short courses in agriculture; H. L. Kempster, assistant professor of poultry husbandry, and P. L. Gainey, instructor in botany.

PROFESSOR WILLIAM HAZEN BOUGHTON, head of the department of civil engineering in the University of West Virginia, has resigned to accept the position of treasurer and general manager of Vassar College.

DR. NICOLAS LEON has been named professor of anthropology at the Museo Nacional, Mexico.

MR. HUGH GUNN, formerly director of education of the Orange Free State, has accepted an invitation from the government of Western Australia to act as adviser and organizer for the university which that state is founding at Perth.

DR. KARL DIEWONSKI, a manufacturing chemist, has been appointed professor of chemistry in the University of Cracow.

DISCUSSION AND CORRESPONDENCE

AIR IN THE DEPTHS OF THE OCEAN

TO THE EDITOR OF SCIENCE: The question has often been asked, how does the air, which is assumed to be necessary for the life of deep-sea fishes, get to those depths. Possibly a satisfactory explanation exists, if not, the following suggested itself to me as a plausible one, and possibly as a new one.

It is well known that the amount of gas which a liquid will hold in clear and stable solution, increases with the pressure. The liquid in a bottle of champagne or in a siphon bottle, for instance, is clear until the pressure is released. It may be assumed that the water on the top surface of the ocean is being continuously saturated with air due to the spraying of the waves. The layer beneath is at a slightly higher pressure, hence will hold more air per unit volume, than the one above it. Under such circustances it seems that there should be a tendency for the air in the top layer to move down to the less saturated one beneath it, until it too is saturated, and this will require a larger amount of air per unit volume. The same is true of the next lower layer, and so on to the bottom.

It would seem to follow, therefore, that air actually descends into the ocean depths, and if it is being consumed there for oxidation and nitrification purposes, there should be a continuous flow of air downward into the deepest ocean waters. If oxygen dissolves in sea water more freely than nitrogen, the deep-sea fishes should be enjoying richer air and therefore should require less of it, than those living nearer to the surface.

CARL HERING

PHILADELPHIA, PA.,
July 31, 1911

THE LIGHTING OF A JET OF HYDROGEN

TO THE EDITOR OF SCIENCE: I have examined perhaps a dozen laboratory manuals for beginners in chemistry with reference to the experiment in which the student is required to light a jet of hydrogen and in every case the directions are essentially the same: wait till the air is all expelled, as indicated by the failure to get an explosion when a test-tube full of the escaping gas is brought over a flame, securely wrap a towel around the generating flask, and bring a light to the exit. Now these directions will certainly result in occasional explosions of the contents of the flask, especially if the laboratory sections are large, with possible serious consequences. The careful student, having been cautioned as to the danger of the experiment, will often wait an undue length of time and will still be nervous about bringing a flame to

the exit; while the less careful worker is likely to attempt to light the gas prematurely.

All possibility of an explosion is removed by a very simple procedure, which is doubtless widely used, but which has not found its way into the manuals. When the air has been completely expelled, the hydrogen will burn tranquilly in the test-tube. The test-tube, containing the burning hydrogen, is, by a quick movement, brought over the escaping hydrogen. One or two trials will be sufficient to ignite the jet. The towel may be dispensed with.

Neither originality nor novelty is claimed for this suggestion. This note is written merely with the hope that some one of the numerous writers of manuals will revise the directions for this particular exercise and discard the time-honored towel.

B. F. LOVELACE

UNIVERSITY OF ALABAMA,
May 25, 1911

QUOTATIONS

THE ADMINISTRATION OF THE DEPARTMENT OF AGRICULTURE

WITH the testimony yesterday of Dr. Wiley himself, the Moss committee concluded its hearings. President Taft will next be heard from. But conditions have changed since Attorney General Wickersham, after reading a cooked-up case, declared that Dr. Wiley and his associates in guarding the foods and medicines of the people merited "condign punishment." Like thunderbolt the illuminating publication that exposed the doings of the McCabe cabal in the Department of Agriculture must have seemed to Solicitor McCabe and his fellow-conspirators just as they thought their secret charges against the Chief Chemist were accomplishing his ruin. The public now knows that the Food and Drugs Act has been officially disregarded; that scores of important cases against alleged adulterators and misbranders have been deliberately held in abeyance; that department officials did not hesitate to garble the terms of court findings, and that an organized effort was being made, by the cutting down of salaries and "star chamber" proceedings, to drive honest public servants out of the Bureau of Chemistry. It is not imprudent to predict that if, in his decision, President Taft recommends "condign punishment," the recommendation will not be directed against Dr. Wiley and Dr. Rusby.—*The New York Times.*

It is not too much to say that Dr. Wiley, in his first day's testimony before the House committee, absolutely riddled the case against him. The so-called documentary evidence upon which Attorney-General Wickersham so gravely passed, was no evidence at all. Its chief piece was a letter to Dr. Wiley, but it now appears that it was never sent to him nor received by him. He had nothing whatever to do with making the contract with Dr. Rusby, for which offence his resignation was demanded. The whole thing was to be "subject to the approval of the Department"—that is, the Secretary—though these words were omitted by the personnel board when it published a copy of Dr. Rusby's letter. It is evident that the Attorney-General was grievously misled; he ought to make haste to recall his opinion and to apologize to Dr. Wiley. As for the schemers against Dr. Wiley, the investigation has left them in a most unenviable plight. Their stay in the public service ought to be of the briefest. And the inquiry has, it must also be said, shown such an unhappy state of affairs within the Department of Agriculture, which appears to be honeycombed with intrigue and faction, and badly suffering for lack of firm, executive control, as to indicate the need of its reorganization from the top down.—*The N. Y. Evening Post.*

SCIENTIFIC BOOKS

Mendelism. By R. C. PUNNETT. Third edition, entirely rewritten and much enlarged. Pp. 192, 5 plates and 35 text-figures. New York, The Macmillan Co. 1911. Price $1.25.

Punnett has shown that a scientific book need not be dull. His new treatise on "Mendelism" is a thorough exposition of a difficult and technical subject, yet it is as entertaining

as a novel. It deals with the new science of genetics, "the experimental study of heredity and variation in animals and plants," and contains the clearest and best account of its rise and present condition that has yet been published in any language. It lacks the encyclopedic completeness and the bibliographic features of the work of Bateson and Przibram, and will of course need to be supplemented by them in the hands of the advanced student, but for the beginner or the general reader who wants within moderate compass a sane and well-balanced account of what has been accomplished in this field, the book is almost ideal.

It does not pretend to give an account of all the work done in this field, but of only so much of it as will serve adequately to illustrate the principles involved. The author writes in his preface:

> In choosing typical examples to illustrate the growth of our ideas it was natural that I should give the preference to those with which I was most familiar. For this reason the book is in some measure a record of the work accomplished by the Cambridge School of Genetics, and it is not unfair to say that under the leadership of William Bateson the contributions of this school have been second to none. But it should not be forgotten that workers in other European countries, and especially in America, have amassed a large and valuable body of evidence with which it is impossible to deal in a small volume of this scope.

The illustrative material, however, has been remarkably well selected, and the wide range of questions upon which it bears speaks eloquently of the industry of the workers in "the Cambridge School" and their clear vision of what are the vital problems in genetics. Needless to say this book is an exposition of *orthodox* "Mendelism." Gametes are treated as beyond suspicion "pure," and unit-characters are regarded as immutable. Variation is supposed to occur only by loss of factors, or by the interpolation of new, "modifying," "intensifying" or "inhibiting" factors, but never by a direct change in the factors that before existed. There are Mendelians who are heterodox or at least have inner questionings about some of these assumptions, and are likely to challenge them in the next ten years as they have in the last ten. But the author has wisely omitted controversial points from a general and introductory account of his subject. His account shows that a really great advance has been made in the study of evolution since the rediscovery of Mendel's law and the readoption of the experimental method of studying variation and heredity.

The book opens with a brief statement of "the problem," of the source of new individuals in the gametes, and their part in the life-cycle. This is followed by a likewise brief but well-proportioned historical account of Mendel's work and of that of his predecessors, as well as of the Darwinian period following Mendel's time. The essential points in Mendel's work are shown to be the existence of unit-characters and their segregation, dominance being an incidental matter. The rest of the book is concerned largely with the development of Mendelian ideas since the rediscovery of Mendel's law in 1900.

The "presence and absence" theory is built up with great skill and clearness from an analysis of the inheritance of comb-form in fowls. This theory has all but replaced the earlier idea of Mendel, that the recessive character is something no less real than the dominant one which obscures it in crosses. The presence and absence theory asserts that the recessive character has no objective existence except as the absence of the dominant one. Punnett, however, like most other Mendelians, retains Mendel's original terminology, even though it has lost its original significance. The small letter used to designate a recessive character means, on the presence and absence theory, only that there is nothing there, and it would seem might as well be dropped in the interest of simplicity. But if it can yet be shown that there are cases in which the recessive character is a reality, as Mendel thought, and not a mere negation, the old terminology may reacquire significance and utility.

A chapter devoted to the "interaction of factors" shows how the presence of one unit-character may affect the manifestation of an-

other independent of it in heredity, and how in other cases the joint action of two or more independent factors may be necessary to produce a single visible result. The cognate subject of reversion next comes in for discussion, and is finely illustrated by examples from the breeding of rabbits, sweet-peas and pigeons. Dominance is the subject of the next chapter, and is shown to be imperfect in heterozygous forms like the Andalusian fowl, or, in other cases, of reversed character in the two sexes, as in horns in sheep.

The origin of domesticated varieties from wild forms is next discussed. It is believed to occur by unit-character variation (mutation) but in several different ways as (1) by loss of factors, a method clearly illustrated in the case of sweet-peas both with historical data and data derived from breeding experiments; (2) by the reduplication of factors; (3) by the interpolation of new factors, in some cases unrelated in character, in others inhibiting in action. "Repulsion and coupling of factors" are hypothecated to explain peculiar ratios or the sex-limitation of characters in heredity. In discussing this subject Punnett follows Bateson closely, assuming that each sex possesses a factor not found in the other, and which repels certain sex-limited characters in gametogenesis.

The production of "intermediates" observed in many experimental studies of inheritance is explained with the help of (hypothetical) supplementary and inhibiting factors.

A finely written chapter on "variation and evolution" contrasts with the older views of the Darwinian period the newer views derived from the study of genetics, and shows how the theory of natural selection has been relieved of the burden of explaining the *origin* of new characters, and required only to explain their perpetuation. Protective mimicry is explained as due to parallel mutation rather than to actual imitation.

Another chapter discusses the economic aspects of genetics in the breeding of animals and plants, and the last one is devoted to "man." This delightful chapter is a literary gem, in which the author's power of keen analysis, of vivid imagination, and of clear exposition show to best advantage, not without a spark of genuine humor and a lot of good sense. He reviews the classic cases of Mendelian inheritance in man, of brachydactyly, night blindness, hemophilia, eye-color, etc. He considers the possible interrelations of physical and mental traits and the scientific basis of eugenics in the following passage:

A discussion of eye-color suggests reflections of another kind. It is difficult to believe that the markedly different states of pigmentation which occur in the same species are not associated with deep-seated chemical differences influencing the character and bent of the individual. May not these differences in pigmentation be coupled with and so become in some measure a guide to mental and temperamental characteristics? In the National Portrait Gallery in London the pictures of celebrated men and women are largely grouped according to the vocations in which they have succeeded. The observant will probably have noticed that there is a tendency for a given type of eye-color to predominate in some of the larger groups. It is rare to find anything but a blue among the soldiers and sailors, while among the actors, preachers and orators the dark eye is predominant, although for the population as a whole it is far scarcer than the light. The facts are suggestive, and it is not impossible that future research may reveal an intimate connection between peculiarities of pigmentation and peculiarities of mind.

The inheritance of mental characters is often elusive, for it is frequently difficult to appraise the effects of early environment in determining a man's bent. That ability can be transmitted there is no doubt, for this is borne out by general experience, as well as by the numerous cases of able families brought together by Galton and others. But when we come to inquire more precisely what it is that is transmitted we are baffled. A distinguished son follows in the footsteps of a distinguished father. Is this due to the inheritance of a particular mental aptitude, or is it an instance of general mental ability displayed in a field rendered attractive by early association. We have at present very little definite evidence for supposing that what appear to be special forms of ability may be due to specific factors. Hurst, indeed, has brought forward some facts which suggest that musical sense sometimes behaves as a recessive character, and it is likely that the study

of some clean-cut faculty such as the mathematical one would yield interesting results.

The analysis of mental characters will no doubt be very difficult, and possibly the best line of attack is to search for cases where they are associated with some physical feature such as pigmentation. If an association of this kind be found, and the pigmentation factors be determined, it is evident that we should thereby obtain an insight into the nature of the units upon which mental conditions depend. Nor must it be forgotten that mental qualities, such as quickness, generosity, instability, etc.—qualities which we are accustomed to regard as convenient units in classifying the different minds with which we are daily brought in contact—are not necessarily qualities that correspond to heritable units. Effective mental ability is largely a matter of temperament, and this in turn is quite possibly dependent upon the various secretions produced by the different tissues of the body. Similar nervous systems associated with different livers might conceivably result in individuals upon whose mental ability the world would pass a very different judgment. Indeed, it is not at all impossible that a particular form of mental ability may depend for its manifestation, not so much upon an essential difference in the structure of the nervous system, as upon the production by another tissue of some specific poison which causes the nervous system to react in a definite way. We have mentioned these possibilities merely to indicate how complex the problem may turn out to be. Though there is no doubt that mental ability is inherited, what it is that is transmitted, whether factors involving the quality and structure of the nervous system itself, or factors involving the production of specific poisons by other tissues, or both together, is at present uncertain.

Little as is known to-day of heredity in man, that little is of extraordinary significance. The qualities of men and women, physical and mental, depend primarily upon the inherent properties of the gametes which went to their making. Within limits these qualities are elastic, and can be modified to a greater or lesser extent by influences brought to bear upon the growing zygote, provided always that the necessary basis is present upon which these influences can work. If the mathematical faculty has been carried in by the gamete, the education of the zygote will enable him to make the most of it. But if the basis is not there, no amount of education can transform that zygote into a mathematician. This is a matter of common experience. Neither is there any reason for supposing that the superior education of a mathematical zygote will thereby increase the mathematical propensities of the gametes which live within him. For the gamete recks little of quaternions. It is true that there is progress of a kind in the world, and that this progress is largely due to improvements in education and hygiene. The people of to-day are better fitted to cope with their material surroundings than were the people of even a few thousand years ago. And as time goes on they are able more and more to control the workings of the world around them. But there is no reason for supposing that this is because the effects of education are inherited. Man stores knowledge as a bee stores honey or a squirrel stores nuts. With man, however, the hoard is of a more lasting nature. Each generation in using it sifts, adds, and rejects, and passes it on to the next a little better and a little fuller. When we speak of progress we generally mean that the hoard has been improved, and is of more service to man in his attempts to control the surroundings. Sometimes this hoarded knowledge is spoken of as the inheritance which a generation receives from those who have gone before. This is misleading. The handing on of such knowledge has nothing more to do with heredity in the biological sense than has the handing on from parent to offspring of a picture, or a title, or a pair of boots. All these things are but the transfer from zygote to zygote of something extrinsic to the species. Heredity, on the other hand, deals with the transmission of something intrinsic from gamete to zygote and from zygote to gamete. It is the participation of the gamete in the process that is our criterion of what is and what is not heredity.

Better hygiene and better education, then, are good for the zygote, because they help him to make the fullest use of his inherent qualities. But the qualities themselves remain unchanged in so far as the gamete is concerned, since the gamete pays no heed to the intellectual development of the zygote in whom he happens to dwell. Nevertheless, upon the gamete depend those inherent faculties which enable the zygote to profit by his opportunities, and, unless the zygote has received them from the gamete, the advantages of education are of little worth. If we are bent upon producing a permanent betterment that shall be independent of external circumstances, if we wish the national stock to become inherently more vigorous in mind and body, more free from congenital physical defect and feeble mentality, better able

to assimilate and act upon the stores of knowledge which have been accumulated through the centuries, then it is the gamete that we must consult. The saving grace is with the gamete, and with the gamete alone.

W. E. Castle

Harvard University

Plant Physiology, with Special Reference to Plant Production. By Benjamin M. Duggar. 13 × 20 cm. Pp. xv + 516, frontispiece and 144 figures. The Rural Textbook Series. New York, The Macmillan Co. May, 1911. Price $1.60.

The growing realization that a rational agriculture must rest upon the principles of plant physiology finds definite expression in the appearance of Professor B. M. Duggar's new text-book. As the title implies, this book is intended for agricultural students and those primarily interested in "plant production," and it should occupy a very necessary and permanently useful place in American agricultural colleges and experiment stations.

The choice of subject matter is governed by the centering of the entire treatment about the idea of the usefulness of plants in human affairs, so that relatively great importance is accorded those aspects of physiology which enter into present agricultural, horticultural and silvicultural theory and practise. Plant physiologists may be surprised to find that other portions of our present physiological knowledge are often but briefly and summarily treated. Thus, the whole subject of movements due to growth receives only about ten pages, while over twenty-six pages are devoted to variation and heredity, subjects as yet hardly to be considered as more than purely descriptive physiology. Many topics not usually treated under physiology find place here, and many illustrative examples are drawn from agricultural experience, so that the book should serve not only as an introduction to things physiological for those who care mainly for the practical manipulation of plants, but also as a key to many important agricultural points for those to whom etiological physiology is of primary interest. The book should therefore find a considerable use, also, in university laboratories. Enough excellently chosen titles are cited from the literature so that the more thorough-going student may find the book an adequate point of departure in the acquisition of a first-hand knowledge of the deeper aspects of the subject.

The literary style of this treatise is frequently abrupt and fragmentary, sometimes ambiguous. Technical terms are now and again introduced without previous explanation, the reader being left to surmise their meaning from the context; also the paragraph often lacks unity. A few examples of ambiguity may be noted. On page 58, regarding *Tillandsia,* we read that it "is provided with much the same type of water-absorbing hairs which give the entire surface a glistening appearance." Hairs have not been mentioned previously in this section, so that the reference of the word *same* is not evident. A comma should precede *which.* Again, on page 65 we find, "this diffusion is wholly independent of any convection currents due to changes in temperature, and it is true for all such soluble substances as sugar, common salt and the like." Here the personal pronoun is without antecedent. On page 195, in the sentence, "As organic matter so called, this element is linked chiefly with hydrogen," etc., "this element" has been mentioned only in the chapter title, "The intake of carbon," etc.

Some surprising inaccuracies occur, several of which may be mentioned here. At the bottom of page 207 "bioses" is obviously intended to denote *disaccharide hexoses.* The word "hydroscopic," page 245, should be *hygroscopic.* In the last paragraph of page 264 the word "hemlock" is used to refer to *Abies alba,* which it is not. On page 294, *à propos* of certain "roots or root branches which seem to be important in aeration," it is stated that "to these organs the term hydathodes has been applied": this word is applied to certain peculiar foliar openings or water pores, through which guttated liquid escapes. On page 402 barley is mentioned as "almost unknown southward," yet it is one of the main hay crops of the southern portions of Arizona

and California and the latter region is prominent in the production of barley grain for malting. The Imperial Valley produces large quantities of excellent barley.

The ancient and still commonly prevalent, though clearly illogical, confusion of osmotic with hydrostatic pressure finds, on page 69 of this text, its most recent expression. We are told that so long as water may be absorbed there is exhibited in plant cells "an hydrostatic pressure known as turgor. . . . Turgor is then the expression of the osmotic pressure of the cell." The Van't Hoff theory of osmotic pressure (gas-pressure theory) has been briefly stated in the preceding paragraph, so that the reader will picture turgor as brought about by the tendency of the solutes of the cell to expand within the limits of the solvent, the former substances being imprisoned within the plasmatic membrane, through which they do not pass. But the reader is now told that the internal pressure which produces turgor is *hydrostatic*, which can only mean that it is due to *water*. He remembers that the plasmatic membrane is permeable to water and becomes hopelessly muddled.[1]

Serious misconception may arise from the following, which occurs on page 440: "The method of reducing toxicity by solid particles [in water-culture solutions] is usually denoted [*sic*] adsorption." Of course the general phenomenon of adsorption is well-known physically and receives a large amount of attention in the recent hand-books of colloid chemistry, so that the implication that this phenomenon is known only, or even mainly, in connection with physiological solutions, is much to be regretted. Following the above sentence comes a brief statement of the usual explanation of adsorption, and then we enter again upon troubled ground, in the statement that "another explanation is that the solid substances offer obstacles to the free movement of the solvent particles." Obviously, "solvent" should be replaced by *solute*, but, even with this modification, the sentence can not stand, for it is well established that the effect of solid particles (such as lamp-black and quartz flour) upon a toxic solution remains manifest after their complete removal from the solution.[2]

In general, Professor Duggar's treatment of the subject is exceptionally *safe;* we find no dogmatic statements in the entire book, and the careful wording will hardly fail to impress upon the student the importance and desirability of that inestimable attribute of the trained thinker, the habit of suspended judgment. The fact that the author employs the word *suggest* where many others would have written *show* or *demonstrate,* indicates clearly the wholesome tendency of the treatment. Indeed, some critics will probably find fault with many paragraphs because of the indefinite conclusions reached; the method of caution is carried farther than it need be at certain points. The reviewer believes, however, that we touch here upon one of the most commendable characteristics of Professor Duggar's work.

Another admirable quality which deserves special mention here is the almost complete avoidance of teleological or anthropomorphic implications. We find no "adaptations" here discussed, and seldom is a process said to occur "for" future "needs." While not absolutely free from teleological lapses—here and there occur such statements as this, that "the seed and tuber are effective propagative devices"—yet the work of Professor Duggar has clearly shown, once for all, that it is quite possible and practicable to discuss plant phenomena without indulging in those anthropomorphic colorings which characterize a still very prevalent type of biological writing. At the same time, our author does not make his book unreadable to the beginner by seeking to put all statements in terms of pure energetics. The secret of his success in this direction lies perhaps mainly in the fact that he develops human interest by emphasizing the usefulness of plants to man, rather than by virtually

[1] For a discussion of a similar statement, made years ago, see Livingston, B. E., "The Rôle of Diffusion and Osmotic Pressure in Plants, p. 31, Chicago, 1903.

[2] For example, see Bulletins 28 (1905) and 36 (1907), Bureau of Soils, U. S. Dept. Agric.

humanizing or personifying the plant through attributing to it various human concepts, such as fear, reason and the like.

Burton E. Livingston

The Desert Laboratory

NOTES ON METEOROLOGY AND CLIMATOLOGY

Rapid progress is being made in the United States in the opportunities for instruction offered to students in meteorology and climatology. Moreover, college students, especially those in medicine, engineering, agriculture and forestry, are showing an increasing interest in these sciences. At the University of Minnesota, where instruction in meteorology was first given only four years ago, the classes under Professor E. M. Lehnerts last year numbered eighty-seven students, being the largest in this branch of science in the country. At the University of Wisconsin there is now a separate department of meteorology in which three courses open to undergraduates and four courses open to graduates and undergraduates are given by Mr. Eric R. Miller, of the U. S. Weather Bureau. As a result of the policy of the university to cooperate with the scientific branches of the national government, the local office of the Weather Bureau is located in one of its buildings, North Hall, and the official in charge lectures in the university. A similar situation is found at Johns Hopkins University. At the University of Nevada instruction in meteorology will be offered for the first time during the coming college year. It will be given by Mr. S. P. Fergusson, formerly of Blue Hill Observatory, who during the past year has had charge of the meteorological work at the Experiment Station in Reno. Mr. W. G. Reed, Jr., for several years past an assistant under Professor Ward in Harvard University, goes to the University of California at the beginning of the new year to teach meteorology and climatology.

A new edition of the "International Cloud Atlas" has just been prepared by MM. A. Hildebrandsson and L. Teisserenc de Bort, to whom the publication of the work has been entrusted by the International Meteorological Committee. The first edition of the atlas, which appeared in 1895, was soon out of print, but it accomplished its purpose—international uniformity in cloud nomenclature and the recording and publication of cloud data by means of symbols. At the International Meteorological Conference at Innsbruck in 1905 certain improvements were suggested, and these have been incorporated in the new edition. The latter consists of complete definitions of the various kinds of clouds and instructions to observers, all printed in three languages, together with twenty-nine photographs of the various types of clouds, which, with their backgrounds, are shaded and colored as in nature. Only clouds of typical form are shown, making it an easy matter for one to recognize the various kinds of clouds and to learn the names by which they are known. The more important changes made in the second edition as a result of the resolutions of the Innsbruck Conference are the following: (1) Stratus cloud is defined as "a uniform layer of cloud resembling a fog but not resting on the ground," instead of "a horizontal sheet of lifted fog." The complete absence of details of structure differentiates stratus from other compact cloud forms. (2) A new term, lenticularis, is used for certain cloud forms, particularly frequent on days of sirocco, mistral or foehn, which have an oval shape and occasionally show irisation. Clouds of this kind are cumulus lenticularis and stratus lenticularis. (3) Observers are urged to designate, by means of a special symbol, a cloud which is specially characteristic of its type, or a cloud from which rain falls. (4) Distinction is also made between a fog which wets exposed surfaces and one in which exposed surfaces remain dry.

Representatives of the weather services of two foreign countries visited the United States recently to study the methods used here. One was Professor Torahiko Terada, of Tokio, Japan, who is at present on a tour

around the world investigating the aerological work of the leading nations. The weather service of Japan is about to inaugurate research of this kind, and for this reason Professor Terada was delegated with the task of studying the methods and inspecting the apparatus now in use in other countries. The second representative was Mr. Edward C. Barton, of Brisbane, Australia, who visited the United States and Canada for the purpose of studying meteorological work with the hope that the information thus gained might be used to improve the Australian weather service. Methods of collecting and disseminating data, forecasting, the publication of weather maps and the instruction offered both under the government and independently among the colleges were especially investigated by Mr. Barton. Pilot and sounding balloons are now used in upper air research in Australia, but kite flying for meteorological purposes has not been begun as yet.

A paper entitled "The Vertical Temperature Distribution in the Atmosphere Over England, and Some Remarks on the General and Local Circulation" was read before the Royal Society of London by Mr. W. H. Dines on May 11, 1911, and is published in the transactions of that society. It is based upon the results obtained from about two hundred sounding balloon ascensions in England during the last four years. He says, "Any one working up these figures can not fail to notice that the temperature of the upper air over England is largely dependent upon the height of the barometer, and that above ten kilometers the temperature is far more dependent upon the barometer than it is upon the season." Tables which he gives show that the lower strata are cold in a cyclone and warm in an anticyclone, a condition which is reversed above. At ten kilometers the intermediate type of weather has the lowest temperature, the temperature gradient ceasing at eight kilometers in the cyclone, but not until twelve kilometers in the anticyclone. Temperature conditions indicate an ascending current in a cyclone starting close to the ground and reaching up to the isothermal region, the stratosphere, and extending over a larger and larger area as it rises, the whole forming roughly the frustrum of a cone with its apex downwards. In an anticyclone it starts from a height of about eleven kilometers, spreading out as it descends, it too forming a cone, but with its apex upwards. The height of the isothermal region varies directly with the barometric pressure at the ground, while the temperature of the air at the commencement of the isothermal varies inversely as the latter. He also finds that the annual range in temperature decreases from the surface up to two or three kilometers; it then continues nearly constant up to about eleven kilometers, at which point it is abruptly reduced to less than half its former value. In the strata above one or two kilometers the maximum and minimum values are delayed for about a month, but above the point at which the vertical gradient ceases they occur at the summer and winter solstices. If the theory of local circulation given be correct it follows that the winds must continue upwards to the height at which the isobaric surfaces are level planes, or rather spheroids concentric with the earth, a height estimated at twenty kilometers.

One of the most valuable fields of activity of the U. S. Weather Bureau is that related to frost, concerning which several interesting articles appear in recent numbers of the *Monthly Weather Review*. In the January number Mr. W. M. Walton, Jr., tells how, after burning 3,300 gallons of fuel oil in heaters placed in a fruit orchard in Indiana during the cold April of 1910, the blossoms were protected until the twenty-second, when a high northwest wind accompanied by a temperature of 25° destroyed all prospects of tree and bush fruit crops. However, two acres of strawberries gave an abnormally large crop after they had been protected by means of 180 oil heaters during three nights of frost with temperatures down to 25° and lower. In two papers in the February number, Professor Alexander G. McAdie, of San Fran-

cisco, tells of efforts to protect California fruits from frosts. It is a matter of credit to the Weather Bureau and its California forecasters that during the winter of 1909–10 in that state there was not a single forecast of injurious frost that was not fully verified, and, what is more satisfactory, there was not a single frost injurious to fruit occurring during that period which was not forecast from twelve to thirty-six hours in advance. Efforts are being made to select hardy plants which will resist low temperatures, to render the plant dormant and not sensitive during the cold periods, and also to fight the cold and minimize exposure thereto by producing heat artificially. In the April number Mr. E. M. Gruss, of Houston Heights, Texas, tells of the beneficial effects of smudge fires to protect the fruit and garden crops in the southern part of that state by means of checking the nocturnal radiation. He points out the necessity of rapid action the moment frost is predicted, and also recommends the use of temporary coverings of hay, straw, soil, slatted roofs or mats, or by means of flooding or spraying. At Grand Junction, Col., in the vicinity of which temperatures as low as 15° were observed on the night of April 12 last, ample forecasts were widely disseminated by telephone, and orchard temperatures were kept above the danger point by means of artificial heating. In the same number of the *Review* Dr. P. F. Homer, of Pleasant Grove, Utah, tells of work being done there to determine the resistance of fruit buds to frost and the factors which bring about the remarkable differences noted whereby a freeze will kill one bud on a twig and leave unharmed another one adjacent to it, or will destroy the blossoms on one tree and not affect another of the same species near by. Mr. W. E. Bonnett, local forecaster at Fresno, Cal., also tells of successful efforts in fighting frost in the California vineyards. On April 13, when the most damaging frost in many years occurred near Fresno, and reliable instruments recorded temperatures of 27°, vineyards were protected by means of fire pots in which was burned a specially prepared fuel of sawdust and shavings. He points out the fact that danger from frosts lies within very narrow limits, and states that growers in his vicinity are awakening to the fact that complete protection is easy and sure. In another note Professor McAdie describes a new device called an "antifrost candle," a cartridge which consists of a cylindrical tube containing slow-burning material. These cartridges are suspended in an orchard just beneath the fruit, the ends are lighted, and the heat produced is distributed at the particular level where it is most needed.

ANDREW H. PALMER

BLUE HILL OBSERVATORY,
August 1, 1911

SPECIAL ARTICLES

THE NITROGEN AND HUMUS PROBLEM IN DRY-FARMING

THE Utah Experiment Station has been conducting investigations for several years regarding the effect of crop production, under strictly dry-farming methods, upon the nitrogen and humus content of the soil. A preliminary report[1] of this work was issued last year. The writer found, contrary to the teachings of modern agriculture, that crop production had not caused a decrease in the nitrogen and humus content of the cultivated soil when compared with that of the adjacent virgin soil.

Recently a criticism of this report appeared in SCIENCE[2] written by Mr. C. S. Scofield, of the United States Department of Agriculture. There are two main points in Mr. Scofield's criticism: first, the characteristic cultural methods in vogue in the Cache Valley, Utah, were not emphasized so as to bring out the differences between these and the methods in vogue in the Great Plains area of the United States; second, the noted increase in nitrogen and humus content was not correlated with the yields on the cropped land.

[1] Utah Experiment Station, Bulletin No. 109.

[2] SCIENCE, Vol. XXXIII., No. 855, May 19, 1911, p. 780.

The writer did not bring out the characteristic differences in the cultural methods in vogue in the Cache Valley, Utah, as compared with the cultural methods in vogue in the Great Plains area. Neither did he bring out the differences in cultural methods in vogue in the Cache Valley, Utah, and in Russia. And why should he? He was writing of neither the soils and cultural methods of the Great Plains area of the United States nor of Russia. He was writing a preliminary report of a purely local phase of the general problem and in this connection he said: "The data presented herein are very interesting and instructive, but one must not generalize too much from the limited amount of information furnished. In studying the results, the nature of the soil and cultural methods of Cache Valley should be kept in mind. . . . *Such soils are probably not found in any other extensive dry-farming district outside of Utah.*"[3] In the face of this statement, it seems difficult to see how any one could accuse the writer of attempting to apply these results to the Great Plains area.

The noted increase of nitrogen and humus was not correlated with the yields of wheat because the accurate yields of wheat were not available. The writer felt that the reputed yields of wheat, obtained from the average farmer, whose only record was his memory and who even had no accurate knowledge of the acreage harvested each year, could have but little if any scientific value. The writer felt that a general statement that "Some of the farms of this district have been under cultivation for forty-five years and apparently yield as good crops as they ever did" was fully as valuable. He still feels that this statement is as valuable as Scofield's[4] regarding the yield of wheat in this same section, wherein he says, "While actual comparison is of course impossible, there are reasons for believing that some of these fields are capable of producing better crops now than when first plowed."

[3] Utah Experiment Station, Bul. 109, p. 15.

[4] U. S. Dept. Agr., Bureau of Plant Industry, Bulletin 103, p. 31.

Since the report was only a preliminary one and the investigation was being continued in the Juab Valley on the Nephi Experimental Farm where the accurate record of yields of wheat was available since the establishment of the farm on virgin sagebrush soil, the writer felt that the noted increase of nitrogen and humus could not but be of interest to agronomists and agricultural chemists in itself, leaving to a future publication the correlation of such an increase with the accurate recorded yields of wheat or other crops.

The investigations on the Nephi Farm have been completed and the results are given herewith. The virgin soil was obtained at the time of the location of the farm in 1903. The samples of virgin soil are composites of twenty-five separate borings on a forty acre tract, so they fairly represent the composition of the soil of the farm in its virgin state.

The samples from plots 82, 83 and 144 were obtained in 1910, seven years after commencement of cultivation. Each sample is a composite of two separate borings.

TABLE I. NITROGEN, HUMUS AND ORGANIC CARBON IN CULTIVATED AND VIRGIN SOIL

Results reported as per cent. of dry soil

Treatment	Depth in Inches	Nitrogen	Humus[5]	Organic Carbon[6]
Virgin soil of farm	0–12	0.116	1.34	0.315
	12–24	0.103	0.89	0.436
Continuous cropped, plot 82	0–12	0.117	1.39	0.558
	12–24	0.092	0.91	0.477
Alternate cropped and fallow, plot 83	0–12	0.108	1.01	0.611
	12–24	0.065	0.78	0.440
Alfalfa, plot 144	0–12	0.110	1.33	0.599
	12–24	0.095	1.38	0.392

The nitrogen and organic carbon have not decreased in the cropped soil when compared with the composition of the same soil in its virgin state. The difference in results for nitrogen in the cropped and virgin soil is

[5] By method of Mooers and Hampton, *Jr. Am. Chem. Soc.*, 1908, Vol. 30, p. 805.

[6] By method of Pettit and Schaub, *Jr. Am. Chem. Soc.*, 1904, Vol. 26, p. 1640.

within the experimental error of sampling and analysis. The total organic carbon has markedly increased in the cropped soil. The "humus" has remained practically the same except on the alternate cropped and fallow plot where a decrease has occurred.

The yearly yields of the plots since the beginning of crop production on this farm are recorded in Table II.

TABLE II. YIELD OF WHEAT ON PLOTS CROPPED CONTINUOUSLY AND ALTERNATELY CROPPED AND SUMMER-FALLOWED

Yield of wheat reported as bushels per acre

Plot No.	1904	1905	1906	1907	1908	1909	1910
82	17.75	8.9	17.9	16.5	13.4	14.58	7.8
83	15.16	fallow	35.6	fallow	32.7	fallow	9.9

The alfalfa plot was utilized for experiments in alfalfa seed production. No yield of seed was obtained. The seed experiment was discontinued in 1908. In 1909 a yield of 2,775 pounds of hay was obtained. The crop failed to mature in 1910.

With respect to the characteristic cultural methods in vogue in Utah, it may be noted that one of the reasons why the grain is harvested with the header is that the straw is so short that it is difficult to use a binder. Wherever a binder is used, the straw is of a ranker growth which permits its use. Now, this being true, it is very doubtful if there be more straw in the stubble on dry-farming land in Utah where the header is used than in the stubble on land where the ranker growth of straw permits the use of the binder. The writer confesses that he knows of no accurate data upon this point.

The explanation of the noted increase of humus and nitrogen in the dry-farming soils of Utah must be sought elsewhere. The effect of the cultural methods, while not of paramount importance, is a possibility which ought not to be ignored. In many sections of the country, such as the Mississippi valley, there is a sharp line of demarkation between the surface soil and subsoil, due to the accumulation of humus in the surface soil formed from the decayed roots of the native grasses and the addition of their residues. The marked change in color of the subsoil indicates that the roots of the native grasses have not penetrated to greater depth. In the soils of Utah, no such line of demarkation occurs between surface and subsoil, which clearly indicates that the roots of the native vegetation have penetrated to great depths. The significance of the deep-rooted character of native plants in arid soil was first noted by Hilgard.[7] The characteristic native vegetation of the dry-farming soils of Utah is sagebrush, the roots of which penetrate to great depths and, being of a woody nature, do not undergo decay rapidly. The foliage is very scant and adds little to the humus-forming material of the soil. The native grasses occasionally occurring with sagebrush are also deep rooted. In a word, there is limited possibility for the formation of humus in the virgin surface soil as compared with other sections of the country where the root system does not penetrate so deep and the native vegetation of a humus-forming type is more abundant. Therefore, in the dry-farming soils of Utah, the addition of *any* straw must increase the organic matter of the plowed surface of the soil as compared with the virgin surface soil which receives little or no organic matter of a humus-forming type. The other factors as noted in Bulletin No. 109 should also be considered in connection with the increase of nitrogen and humus in the cultivated soil.

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DIVISION OF INDUSTRIAL CHEMISTS AND CHEMICAL ENGINEERS

G. D. Rosengarten, *chairman*
F. E. Gallagher, *secretary*

The Rapid Analysis of Alloys: GUILLERMO PATTERSON, JR.

The Testing of Inks, Typewriter Ribbons and Carbon Papers: PERCY H. WALKER.

[7] "Soils," p. 174.

Hop Standards: Considered from the Chemical Standpoint: H. V. TARTAR.

Losses in the Storage of Coal: HORACE C. PORTER and F. K. OVITZ.

The paper describes tests made by the U. S. Bureau of Mines at various points during the last three years to determine the loss in heating value and the physical deterioration of several kinds of coal while in storage. Tests at various U. S. Navy Yards (Portsmouth, N. H., Norfolk, Va., and Key West, Fla.) and at the Pittsburgh station of the Bureau, on New River (W. Va.) coal, have been carried on for eighteen months both in the open air and under water, so as to show the amount of the saving accomplished by the latter method. Pocahontas coal has been stored in the open air on the Isthmus of Panama for nine months, and is being tested to show the deterioration of this grade in a hot climate. Pittsburgh gas coal has been stored in open bins exposed to the weather at Ann Arbor, Mich., and also submerged under water, so as to determine both the loss of heat value and the deterioration in gas-making qualities (the latter phase of the investigation being under the auspices of the University of Michigan and the Michigan Gas Association). Sheridan (Wyo.) sub-bituminous coal (black lignite) was stored in outdoor bins at Sheridan, Wyo., for nearly three years, and the amount of deterioration and slacking under different conditions determined.

The results show briefly that deterioration in the open varies considerably with the kind of coal, the Appalachian coals being only slightly affected while the younger coals of the west, which differ from the Appalachian in their chemical character, are more easily oxidized and weathered.

New River coal loses less than 1 per cent. in heating value during open-air exposure for one year, and no loss at all occurs during storage under water. The wetting of the coal by submergence reduces its evaporative power more than enough to offset any saving accomplished through the prevention of deterioration. The only advantage of submergence in case of this coal, therefore, is the avoidance of all risk of spontaneous combustion. Fine coal deteriorates more in all cases than run-of-mine.

Pocahontas coal, during nine months' open-air storage at Panama, lost only 0.3 per cent. in heat value. Sheridan, Wyo., sub-bituminous lost 3–5 per cent. in heat value during three years' storage in outdoor bins and slacking penetrated only about one foot from the surface. Pittsburgh gas coal stored in outdoor open bins lost nothing in heat value during the first six months.

Need of Professional Code of Ethics among Chemists: LUCIUS P. BROWN.

Storage Battery Efficiency: J. S. STAUDT.

A New Modification of Gas Analysis Apparatus: B. G. KLUGH.

Refractories and Laboratory Appliances made of Alundum: P. A. BOECK.

The rapid advance in high temperature work and furnace construction during the past few years has necessitated the development of a high-grade refractory material to withstand excessive temperatures. Electrically fused alumina has long been known to have exceptional refractory properties, but on account of the difficulties in the manufacture of articles of this material its use has been limited. Fused alumina under the trade name of "alundum" has been made for abrasive purposes for the past ten years by the Norton Company, Worcester, Mass., who have lately adapted this material for refractory purposes.

There are two varieties of fused alumina or "alundum" made.

One is a dark, brown, dense vitreous body having a density of 3.9 and a hardness between corundum and diamond. This is made by calcining bauxite and fusing it in a water-cooled electric furnace, where the impurities in the form of iron oxide, silica and titanium oxide are reduced to a considerable extent, leaving the material in the furnace 92 to 95 per cent. alumina. The other is a material of higher purity, containing more than 99 per cent. alumina, made by carrying the purification process further. This is the material most generally used for refractory work.

The alundum comes from the furnaces in pigs weighing about five tons each, which are broken up, crushed and graded to grain of a uniform mesh. In making refractories of this material grain of a suitable size or combination of sizes is mixed with a refractory bond of a ceramic nature and the pieces molded, pressed or cast into shape and fired at high temperatures. The kind and amount of bonding material, and the size or combination of sizes of grain used, are varied to give properties to suit the conditions under which the articles are to be used. In this way their properties may be modified or controlled to adapt them to any refractory use. Attempts have been made to make articles of cast alundum, which have been only partially successful.

The physical properties of bonded alundum refractories are as follows:

High Melting Point.—Between 1,950 and 2,100 degrees Centigrade.

High Thermal Conductivity.—2.1 times that of vitrified firebrick and 1.6 times that of porcelain.

Low Electrical Conductivity.—Even at elevated temperatures it is a better insulator than porcelain.

Low Thermal Expansion.—This is linear and varies between .0000085 and .0000059.

High Mechanical Strength.—This can be varied and is dependent to a certain extent on the other properties desired.

Porosity.—This can be varied between wide limits from impervious bodies to those having a high porosity which can be used for the filtration of liquids of any gravity.

Filtering crucibles of the gooch type can be used for filtering precipitates quantitatively without any previous preparation and can be used repeatedly.

Extraction thimbles are made for all kinds of extraction work and can be cleaned by igniting over a gas burner.

This material is especially useful in small wire wound resistance furnaces, as it prevents overheating and corrosion of the resister and has high thermal conductivity.

Crucibles for analytical work of a general nature such as drying and burning filter papers, coal analysis, etc., have been found more rapid and longer lived than porcelain. Crucibles for melting platinum and high melting alloys, where no slags are present, have been found very efficient.

Combustion boats of alundum are useful in the determination of carbon in steels, as the iron oxide formed does not combine with the alumina at the temperature of combustion. For very high temperatures it has been found advisable to use a lining of specially prepared carbon-free alundum between the boat and the sample. When used in this way the boats last indefinitely, as many as 500 combustions having been made in the same boat.

The Determination of Vanadium in Vanadium and Chrome-vanadium Steels: J. R. Cain. (*Bull. Bur. Standards*, 7, No. 3, p. 377; *J. Ind. and Eng. Chem.*, 3, July, 1911.)

Various errors in the usual methods for determining vanadium in steel are pointed out and in a few cases methods for correcting or eliminating these are indicated. A new method based on precipitation of the vanadium by cadmium carbonate followed by electrolysis, reduction and titration, is described.

Determination of Dust in Blast Furnace Gas: L. A. Touzalin.

Dust determinations can be made in any blast-furnace gas at any stage of its passage from the furnace to stoves, boilers or cleaners, if proper means are used to insure the correct rate of withdrawing the sample from the gas main. When samples are withdrawn through a sampling pipe at a velocity less than that in the main, high results will be obtained. Conversely, when the sampling velocity is too great low results are obtained. By means of the proper apparatus, described in the paper, very satisfactory efficiency tests may be run on a system of gas cleaners. This leads to the development of changes in construction which often have a remarkable effect on such efficiency. The apparatus described and the method of operating the same are in constant use at the South Works of the Illinois Steel Company.

The Examination of Fir Oil obtained by Steam Distillation of Douglas Fir: Henry K. Benson and Marc Darrin.

The Wood Distillation Industry of the Pacific Northwest: Henry K. Benson.

Ratfish Oil as a Paint Material: Henry K. Benson and Wallace Eshleman.

Note on the Analysis of Nitrous Oxide: Warren R. Smith and Edwin D. Leman.

On attempting to analyze nitrous oxide as supplied in cylinders in the liquid state, we found ourselves confronted with certain difficulties. Consecutive samples of the gas as drawn off from the cylinders will vary somewhat in composition, apparently for the reason that the impurities (oxygen and nitrogen) are in solution in the liquid nitrous oxide, and sample of gas as drawn may or may not have reached a state of equilibrium with the liquid. This evidently will depend on the rate at which the sample is drawn, the length of time elapsing between drawing samples, and various other factors. Duplicate results can easily be obtained from a sample large enough for several analyses, but there is no certainty as to what such a sample represents. Again there is a regular progressive change in the composition of the samples as drawn from the cylinders. The impurities escape at a more rapid rate proportionally than the nitrous oxide in which they are dissolved, and the nitrogen escapes faster than the oxygen. Below are three sets of figures obtained from the same cylinder of material.

	True Content of Cylinder	Nearly Full	Nearly Empty
Per cent. O_2	1.4	2.9	0.7
Per cent. N_2	5.2	11.2	1.6
Per cent. N_2O	93.4	85.9	97.7

We found that all these difficulties can be avoided by the simple expedient of inverting the cylinder and drawing a sample from the bottom of the liquid. That this method gives a fair sample we have proved by drawing a sample in this manner and comparing the result obtained from this sample with that obtained by taking samples at regular intervals during the escape of a whole cylinder of the gas, plotting the results obtained from these samples on rectangular diagram paper and calculating percentages from the areas so obtained.

	From Inverted Cylinder	From Diagram
Per cent. O_2	1.1	1.0
Per cent. N_2	3.1	3.3
Per cent. N_2O	95.8	95.7

Oxygen was determined by absorption with pyrogallate, nitrous oxide by explosion with hydrogen, and nitrogen by difference. No impurity other than oxygen and nitrogen was detected in the cylinders examined except in one specimen which contained a small amount of carbon dioxide.

The variation in composition in the gas as drawn from the cylinder must be of significance in the administration of the gas, and the method of getting a fair sample should be applicable to other liquefied gases such as carbon dioxide and ammonia.

A Differential Test for Chloride and Dioxide Substitutes: Chas. P. Fox, Akron, Ohio.

The reclaimed rubber trade recognizes two grades or varieties of "*so-called*" substitutes. These substitutes have their origin in certain very soft rubbers which have been *firmed* or *hardened* by action of chemicals. They are known as "chloride" or "dioxide" substitutes. Often it is interesting and valuable to trace the method of manufacture of these grades. The following method suffices:

Fuse in a large *nickel* crucible a mixture consisting of *sodium* or *potassium hydrate* and *potassium nitrate* (1 to 5). Add the rubber, in fine pieces, slowly, using cover on crucible and continuing fusion until a white mass, on cooling, is obtained. Cool; dissolve in hot water, acidify with nitric acid, boil thoroughly to expel carbon dioxide and nitrous acid fumes and filter. Add to filtrate excess of *barium nitrate;* a white precipitate indicates sulphur. Remove the barium sulphate by careful filtration and add *silver nitrate;* a white precipitate shows presence of *chlorine.* The presence of both of these precipitates indicates a chloride substitute. The presence of sulphur alone gives the clue to a sulphur dioxide production.

By using *one* gram of the substance and 10 grams of the fusing mixture the test is easily carried out with definite results. A blank test should always be conducted with the reagents, especially those concerned in the fusion operation. In most cases the blank test will give an opalescence with the silver solution. However, if the amount stated has been used and chlorine be present the precipitate will be heavy enough to remove all doubts.

Marine Fiber: Chas. P. Fox.

American Consul John F. Newell, at Melbourne, Australia, has recently called attention to the use of a seaweed fiber in the manufacture of textiles. This fiber has its origin in the leaves and stems of *Posidenia Australis.* Large quantities of this fiber are found in Spencer Gulf. According to the Jewell report, extensive deposits ranging from four to twelve feet in thickness are found, in shallow water, mixed with clay and sand and shells. The material is dredged, roughly dried on the beach, and then transported to the factory, where it is cleaned, sorted and baled.

The raw material is light brown, resembling unbleached flax fiber. Fiber mixed with numerous pieces of flat, satin-like leaves. The separate fibers vary in length from one to six inches. They are firm, smooth and only of slight strength. This fiber finds a use in the manufacture of certain classes of woolens. When mixed with wool it is said to weave and dye better than cotton and to be much cheaper.

Through the kindness of Mr. Holweeay, of Brown & Dureau, Melbourne, we have examined samples of the crude fiber and of cloth containing one third marine fiber, one third wool and one third cotton. In weaving, Lincoln or Crossbred wool gives better results than Merino.

This fabric weighs 8 oz. per square yard and gives a tensile, per 1 in. width, of 22 lbs. for both filler and warp.

A Method of Analysis of Lead Ores: John Waddell.

This paper gives details of a method of determining lead in ores, especially those rich in lime.

The method consists in precipitating the lead as chromate, which, when dissolved in hydrochloric acid, liberates iodine from potassium iodide and the iodine is titrated with sodium thiosulphate.

A Method of Analyzing some Commercial Gold Alloys: JAMES O. HANDY.

Gold alloys containing Au, Ag, Cu, Zn and Sn are reduced to filings for analysis.

0.5 gram is dissolved in aqua regia, 4 HCl: 1 HNO_3. The excess of acid is boiled off, the liquid is diluted and AgCl precipitated by boiling. Filter, wash, dry and weigh.

Filtrate plus 5 per cent. of concentrated HCl, is treated with H_2S. In the filtrate from the sulphides, the Zn is separated as carbonate and weighed as oxide.

The SnS is dissolved out of the sulphide precipitate by 30 per cent. HCl, and is again precipitated as SnS after nearly neutralizing with ammonia. Weigh as oxide.

The Cu is dissolved out of the Au + CuO mixture obtained by burning off the sulphides of gold and copper. Concentrated HNO_3 is used. H_2SO_4 is added and the HNO_3 boiled off. After cooling, water and sodium acetate are added. Boil, cool, add KI and titrate Cu by hyposulphite.

Au and Ag are determined by scorification with lead and borax—silica flux. A "control" assay to check losses of Au and Ag is run with a mixture of metals of approximately the formula of the alloy itself. The Au and Ag are determined together and then separated in the usual manner. Results by corrected fire-assay are more exact than by wet methods in most hands.

Alloys of gold containing up to 26 per cent. Ag, 18 per cent. Cu, 7.5 per cent. Zn and 2 per cent. Sn have been successfully analyzed by this method.

Concentration and Purification of Iron Ore, High in Sulphur, by Roasting in a Rotary Kiln: JAMES O. HANDY.

DIVISION OF FERTILIZER CHEMISTRY

Paul Rudnick, *chairman*

J. E. Breckenridge, *secretary*

Note on the Neutral Permanganate Method for the Availability of Organic Nitrogen: JOHN PHILLIPS STREET.

Further tests with experimental mixtures, in which the permanganate availability of the nitrogenous material was known, showed that under certain conditions very misleading results were obtained, particularly with certain high-grade ammoniates like dried blood. Investigation showed that muriate of potash had no effect on the availability results, but that as the relative amount of acid phosphate was increased the availability of the nitrogenous material decreased, for instance, dried blood from 97 to 59 and tankage from 91 to 78. It was found that the addition of one gram of sodium carbonate prior to the introduction of the permanganate solution gave results close to theory with all the materials tested, except garbage tankage which gave somewhat high results, but not high enough to lead to erroneous interpretation of the analysis.

The Use of Fused Silica Dishes for Potash Determination in Fertilizers: W. D. RICHARDSON.

The Availability of the Insoluble Nitrogen in Certain Commercial Fertilizers: B. L. HARTWELL and F. R. PEMBER.

Results secured by growing crops in pots showed that the insoluble nitrogen of twelve potato fertilizers made by different manufacturers must have been derived from fairly high-grade material. The availability of this nitrogen was found to be about the same both by the crop results and by the alkaline permanganate method recently adopted by certain northeastern states for the laboratory determination of the character of the materials used as sources of the insoluble nitrogen of fertilizers.

The Use of Alundum Crucibles for Total Phosphoric Acid and Potash Determinations in Fertilizers: W. D. RICHARDSON.

The Availability of Nitrogen in Complete Fertilizers: JACOB G. LIPMAN.

Notes on Estimation and Valuation of Potash: P. F. TROWBRIDGE.

Reports from the following committees were received and will be published in the *Journal of Industrial and Engineering Chemistry:* Paul Rudnick, for the committee on nitrogen; G. A. Farnham, for the committee on phosphoric acid; J. E. Breckenridge, for the committee on potash; C. F. Hagedorn, for the committee on phosphate rock; F. B. Carpenter, for the committee on fertilizer legislation.

DIVISION OF PHARMACEUTICAL CHEMISTRY

B. L. Murray, *chairman*

F. R. Eldred, *secretary*

A Few Results Obtained from Pepsin Assay: O. P. EYRE.

Observations upon the Assay of Digestive Ferments: HOWARD T. GRABER.

The three classes of organic foodstuffs considered and the rôle each plays in the nutrition of the body. Proteids are the principles from which all living cells are made, while the carbohydrates and fats serve as the natural fuel foodstuffs of the body.

Digestion considered as a chemical process and can be brought about by pure chemical means, but much more slowly than by the digestive enzymes or ferments.

Enzymatic activity considered. Characteristics peculiar to the enzymes: (1) distinctly specific in their activity, (2) their reactions are incomplete, (3) reactive to environment, (4) the *kind* of proteid, albumenoid or starch acted upon a big factor in the ultimate amount digested.

The enzyme pepsin considered; showing by experiment that the fresh egg of the epicure and housekeeper is not so easily digested as one from five days to one week old.

The enzyme pancreatin considered.

The two assays of the pharmacopœia discussed and a third assay recommended which measures the amount of steapsin or the fat splitting enzyme present.

Pancreatin is more active upon corn starch than upon potato starch.

The enzyme rennet and a method recommended for its standardization. As in the animal kingdom we have juices whose specific function is to tear asunder the food material to make it available for the needs of the body, so in the plant kingdom we find analogous enzymes whose function is exactly the same, that is, to render the plant foods assimilable. Most important of these from our standpoint are bromelin and papain. Bromelin is the enzyme existing in the fruit of the pineapple. Papain exists in the fruit of the pawpaw, a tree growing in the Bahamas and West Indies. Collection of papain described and an assay recommended by means of which the amount of raw beef digested by the papain in a definite period of time is determined.

Conclusions—(1) The composition of the white of the egg, chemically and probably even physically, when used for the assay of pepsin, has a great bearing upon the apparent strength of this ferment. The albumen seems to be more difficult to digest the first twenty-four hours after the egg is laid, and a change gradually takes place until after about five to seven days it has reached its maximum solvent condition. After this period its digestibility gradually diminishes.

(2) In the assay of pancreatin for starch hydrolysis, as well as all the diastasic ferments, the kind of starch used is of prime importance, and in stating the strength of each it should be in terms of the particular starch employed.

(3) The papain seems to be equally active on any kind of raw beef when acting in an acid media, but if the character of the beef is changed, as, for instance, by cooking, papain loses its solvent action upon the proteid.

(4) Rennet is influenced, in testing its coagulating power, by: the condition of the milk, its chemical composition such as the presence and quantities of inorganic salts, particularly those of calcium; the manner of mixing the rennet with the milk; the brand of cows from which the milk is taken, and, lastly, the temperature at which the milk was kept before using and during the test.

Pharmacopœial Revision: JOSEPH P. REMINGTON.

Investigation made with Dry Egg Albumin, in View of Replacing the Albumin Coagulated in the Egg, for Greater Accuracy in the U. S. Pharmacopœia Pepsin Assay: A. ZIMMERMAN.

Laboratory Studies of Pepsin, Pancreatin and Combinations of these Ferments: A. ZIMMERMAN.

Precipitated Sulphur, a Study of a Dermatological Prescription: EDW. KREMERS.

The Moisture Content of Drugs: EDW. KREMERS.

A Study of the Bromine and Iodometric Methods for the Determination of Resorcinol: C. M. PEIRCE.

The iodometric method is of little value. The bromine method gives good results only under certain conditions.

Too large an excess of KI causes some decomposition of tri-brom-resorcinol. Considerable dilution before addition of KI causes precipitate to dissolve, permits a rapid reversal of tri-brom-resorcinol brom and counteracts tendency for decomposition of tri-brom-resorcinol.

The bromine methods as recommended for determination of resorcinol in commercial resorcinol is briefly as follows: prepare a 500 c.c. aqueous volumetric solution containing 1.4563 g. resorcinol; withdraw 25 c.c. portions; dilute with 500 c.c. water; add 5 c.c. HCl and let set 1 minute; dilute with 200 c.c. water; add 5 c.c. KI 20 per cent. and let set 5 minutes; titrate liberated iodine with N/10 thiosulphate using starch as indicator. The number of cubic centimeters of N/10 Br consumed divided by .4 gives percentage of resorcinol.

Estimation of Morphine by Extraction with Phenyl-ethyl Alcohol: A. D. THORBURN, Indianapolis.

An aqueous solution containing morphine is made alkaline and shaken with a mixture of phenyl-ethyl alcohol and benzene; the solution of the alkaloid in phenyl-ethyl alcohol is then partially evaporated and titrated. The method is designed for quantities of sample representing less than .175 gm. anhydrous alkaloid and can be completed in about four hours.

The Relation of the Alkaloids of Gelsemium to One Another: L. E. SAYRE.

The Volatile Acidity of Tragacanth and other Gums: W. O. EMERY.

A Modified Form of Repercolation: E. G. EBERHARDT, Indianapolis, Ind.

The author discussed the advantages of repercolation, gave results obtained on cimicifuga and gentian by triple percolation, as shown by extractive determinations made in successive fractions of percolate and describes a continuous or serial method of percolation giving results obtained in its use.

Tincture Cantharides: E. G. EBERHARDT, Indianapolis, Ind.

The sparing solubility of cantharidin in alcohol makes a 10 per cent. alcoholic tincture impracticable. The author gives results obtained in various attempts to secure a full-strength tincture and gives two methods by which cantharides may be exhausted, one of these depenuing on the conversion of cantharidin into cantharidate, and extraction with dilute alcohol, but yielding a preparation which is but weakly irritant, the other depending on the liberation of combined cantharidin in the drug by an acid and extraction with acetone, yielding an actively vesicant preparation.

Notes on the Iodometric Determination of Strength of Formaldehyde Solutions: JOSEPH S. CHAMBERLAIN.

The Pharmacopœial Standard for Desiccated Thyroid Glands: REID HUNT and ATHERTON SEIDELL.

The Manufacture and Testing of Drugs (illustrated): W. A. PEARSON.

Acetate Collodion: EDWARD C. WORDEN.

Attention is called to the combustibility of the pharmacopœial pyroxylin, and to the inflammability of the official solvents directed to be used in the preparation of the collodions. The replacement of pyroxylin by cellulose acetate is advocated, and attention drawn to the use of acetate collodion in photography, where it has long since passed beyond the experimental stage. Uninflammable cellulose acetate combined with chloroform, carbon tetrachloride or tetrachlorethane, all of which fluids are unburnable, the author believes would result in the formation of transparent, clear, adhesive solutions, possessing all the desirable properties of the present pharmacopœial and National Formulary collodions, with entire absence of inflammability. A bibliography of 300 citations is appended.

Aromatic Spirits of Ammonia: LINWOOD A. BROWN.

Rapid Determination of Beeswax and Honey: FRED KLEIN. (Read by Frank R. Eldred.)

The Accelerating Action of Hydrochloric Acid upon the Starch-converting Properties of Pancreatin and Malt: A. ZIMMERMAN.

The Estimation of Minute Quantities of Nitroglycerine: WILBUR L. SCOVILLE.

Nitroglycerine given medicinally in doses of 1/1000 to 1/20 grain. The material used a 10 per cent. alcoholic solution or a 20 per cent. powder mixture containing some carbonated alkali. Both materials variable in strength and somewhat unstable, and a loss also occurs in the process of manufacturing, so that an accurate and reliable method of estimation in mixtures is needed. The alkaline-titration method of no value. The nitrometer requires special skill for good results.

By the use of phenoldisulphonic acid colorimetrically, as in the estimation of nitrates in water, quantitites of 1/100 grain or less can be accurately estimated. The process is rapid and requires no special skill. It is particularly adapted to the estimation of nitroglycerine in tablets, pills, solutions, etc.

The Determination of Camphor in Spirits of Camphor: L. D. HAVENHILL.

A New and Accurate Method for Determining the Tryptic Value of Pancreatin: C. F. RAMSAY.

The U. S. P. method for testing pancreatin on milk is indefinite and inaccurate because of the end reaction. By the use of rennin for determining when the milk has been peptonized, an accurate method for determining the tryptic value of pancreatin has been worked out.

Commercial samples of pancreatin are found to vary in strength from 1:120 to 1:1,750.

(To be continued)

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THE CHEMICAL PHILOSOPHY OF THE HIGH-SCHOOL TEXT-BOOKS[1]

At the present time the conception of continuity or unity or uniformity plays a great part in all departments of science; not only that continuity in time postulated by geologists and paleontologists, but the idea that all the divisions and classes established by science are but convenient though perhaps indispensable tools of the human mind, while nature, the object of our study, is one and indivisible.

To take examples from biology: modern systematists agree that the conceptions genus, species, variety, race, shade into one another, so that what in one group are regarded as generic distinctions, in another are hardly allowed to differentiate species; the very word biology recognizes the non-existence of a boundary between animal and vegetable; and a group of workers of the present day are busy removing even the distinction between inanimate and animate.

This view of nature, though now so widely accepted, is by no means contemporaneous with the birth of modern science; it came in only when the study of the most striking—because extreme—objects or relations had been followed by that of the less strongly characterized connecting links; and its acceptance has been hindered, in many cases, by the prevalence of certain extra-experimental or extra-observational "explanations" made up to account for the earliest studied, exceptional, phenomena.

[1] Address of the vice-chairman of the Division of Inorganic and Physical Chemistry, American Chemical Society, Indianapolis meeting, 1911.

Thus modern geology was preceded by a period of explanation by "catastrophes," and modern biology by a period in which the theory of separate creation of each of the Linnean species was elevated almost to the rank of a religious dogma; in both cases the main difficulties the new view (of continuity, as I am calling it) had to encounter, were due to the wrench it cost to break with the old familiar extra-experimental theories or explanations. This again was to be expected; the theories were invented by men whose minds were deeply impressed by certain observations or relations, their object was to "explain" these relations and keep them before the mind, so that the theories can hardly be blamed if in addition they kept out of the mind more recently discovered facts whose existence their originators never suspected.

Our own science has passed through a similar evolution. Modern chemistry began with the study of the most striking of all chemical phenomena, the phenomena of combustion; and just when these were robbed of much of their mystery by the discovery that like other chemical reactions they obeyed the law of conservation of weight, a new interest was awakened by the discovery of phases of invariable composition, the typical chemical compounds, whose study laid the foundations of quantitative analysis, and led to the remarkable so-called laws of chemical combination which Dalton's atomic theory was invented to explain.

The existence of such compounds is familiar enough to us, but a century ago one of the most celebrated chemists of his day strove for eleven years to show that no such things could be. This may serve as a measure of the interest and attention attracted by these substances at the time of their discovery; no wonder they alone were designated "chemical" compounds, small blame to those who thought that substances so striking in some respects must prove unique in all; how natural that the idea of continuity advocated by the defeated Berthollet should be forgotten, most natural that the extra-experimental theories invented at the beginning of the nineteenth century should make a sharp distinction between these chemical compounds and all else.

They did so; and as all good theories of that type do, they kept men's minds on the facts they were invented to explain; while the slowly accumulating "exceptions"—facts out of harmony with the tendency of the theory—being unexplained, and thus lacking a powerful aid to publicity, failed of their due influence on opinion. The discovery of the dissociation of chemical compounds by Deville and Debray—that marble, for instance, could be formed or broken up by the action of an air-pump—had surprisingly little effect at the time; but the work of Horstmann, Gibbs and van't Hoff, not to mention lesser lights by name, has at last made it abundantly clear that the "affinity of the atoms" which binds together the constituents of chemical compounds is subject to the same laws and may be measured in the same way as the forces —hitherto deemed distinct—which are responsible for the formation of solutions and adsorpta.

Thus, hand in hand with the study of chemical equilibrium, the idea of continuity entered chemistry, and has transformed it.

The high-school text books, however, as a class, in their tendency deny this continuity *in toto*.

In them the chemical compound and the element ("chemical individuals" for short) retain their former place as "the only two distinct kinds of matter"; and mechanical mixtures are distinguished by being separable into their ingredients "by mechanical means," thus ignoring the fact

that mechanical means have been found for separating the ingredients of whole groups of chemical compounds, and the modern view that the amount of mechanical work necessary to bring about the separation is the only measure we have of the affinities that brought about their union.

Solutions, in some of these books, are openly classed with the mechanical mixtures, and in all are spoken of in language applicable properly to the latter alone. In brine, for instance, salt and water are said to "retain their properties unchanged." Not to dwell on the ridiculous illustration found in many, that "the salt retains its taste"—as though dry salt could be tasted—this assertion ignores the lowering of the vapor tension of the water, and consequently the lowering of its most characteristically "chemical" property, its chemical potential, or power to enter into reaction. Pure water, to give an instance, reacts at 30° C. with the chemical compound sodium sulphate to form its hydrate Glauber salt, also a chemical compound; the reaction is thus "chemical" in the strictest sense of the word, as none but chemical compounds are involved; when combined with salt to form a saturated brine, however, this power of the water is lost.

The change of chemical properties which is ignored when a solution is formed, is exaggerated when a chemical compound is the result of the union; in that case, "an entirely new substance" is produced, whose constituents have "lost their characteristic properties." Now, surely, the most characteristic property of oxygen is to oxidize; does it lose the power of oxidizing carbon by combining with copper? if so, how are the "combustions" of the organic laboratory to be accounted for? Does it lose this power by combining with hydrogen? if so, what about the manufacture of water gas? In truth, as was the case with water in brine, the characteristic properties of oxygen in copper oxide and in water are lessened, not lost. It is not even safe to say that chemical combination always brings about the greater change; as Bell has shown, water combined in washing crystals is more "itself" than when sucked up by a dry cigar.

It might be urged in extenuation of this exaggeration, that, after all, chemistry, like other sciences, works by classification, and that children like distinctions sharp. The heroes of boys' books are heroes every inch; their fools and villains likewise Simon pure; and all agree that problem plays—where the problem is to tell the villain from the fool and to guess who is the hero—are not for such as they; a little exaggeration might therefore be defended as good pedagogy, and suited to the childish mind. This might be a good excuse, if it were not that (no doubt in order to be up to date) the texts while denying continuity, include much of the experimental evidence which has forced this conception into our science. The result is that they contradict themselves, and involve the whole subject in a maze of vagueness and mystification foreign to the scientific spirit; an example or two of each will be given, beginning with a typical instance of self-contradiction.

Most of the texts give their readers the impression that gunpowder is regarded as a mixture containing niter, or that sulphur and iron filings form a mixture containing sulphur, or that the high-school grocers' mixture of sand and sugar is a mixture containing sugar *because* the niter or the sulphur or the sugar can be leached out or dissolved by water or by carbon bisulphide, that is, by liquids which dissolve those solids when pure. It is sometimes added that the ingredients of the mechanical mixture have thus been

separated by the "mechanical operation" solution. And yet, every high school chemistry gives instances of solid chemical compounds decomposed by water, and some even speak of the hydrolysis of salts like bismuth nitrate, which can be formed by bringing together bismuth hydrate and nitric acid of the proper concentration and from which by treatment with water all the nitric acid can be removed, leaving the bismuth hydrate behind. Such instances of self-contradiction (where the major premise of some argument is quietly negatived elsewhere in the book) are scattered broadcast. "In spite of the most carefulness," to quote from the advertisement of a new German balance, "the rider *will* fall"; and the most carefulness has certainly been employed in books which use syrup instead of brine in their illustrations out of respect for the ions, and which the Roozeboom diagram has driven to substitute platinum for iron in the old misleading statement that "powdered iron, magnetized iron, glowing iron and melted iron are just as truly iron" as a cold poker. For one illustration is as bad as another if it is used to confound solutions with mechanical mixtures, or to obscure the fact that chemical properties change with the temperature, and in some cases are measurably affected even by fine grinding.

The vagueness of the texts, already referred to, serves to keep their self-contradiction in a measure hidden. If every statement is indefinite, all can be reconciled; and what could be less definite than the customary definition of an element as a substance from which "nothing simpler than itself" can be obtained, if the meaning of "simpler" is left to be guessed? Unless perhaps it be the definition of a molecule as "the smallest quantity of a compound that can exist alone," or the corresponding indefinitions of atom, affinity, stability, valence, solvent and solute.

This vagueness is, naturally, most marked just where clearness of thought and precision of statement would show the untenability of the exceptional position assigned to the chemical individual; so that it is hardly surprising to find that not one of the texts gives a working definition (*i. e.*, one that can be applied in the laboratory) of the very group of substances which figures so prominently in all of them.

One of the Best Sellers defines chemical changes as "those which involve a change in the composition of the matter," while "sugar may be dissolved in water, but neither the sugar nor the water is changed in composition." This book, like the rest of them, brings in all the usual extra-observational hypotheses to "explain" the ordinary "laws of chemical combination," but gives no explanation whatever of this most extraordinary use of the word "composition"; although on this indefinition of chemical change is based the definition of chemical compound, that of mechanical mixture, and by implication that of chemical affinity as well.

Let us enquire what significance is attached in the practise of the present time to the terms mechanical mixture and chemical compound; we shall then be in a position to appreciate the difficulty in which the text-books find themselves and from which they seek to escape by the employment of systematic mystification as an aid to teaching.

Mechanical mixtures which for years have posed in the pages of Dammer as chemical compounds, are by the application of the phase rule daily being removed. What criterion has been adopted in each of these cases? Stripped of technical terminology it is: Whenever the reacting

power, or potential, of a given substance (say niter) at fixed temperature and pressure is not affected by bringing it together with certain other substances (sulphur, charcoal) the resultant body is to be classed as a mechanical mixture with the substance in question (niter) as one of the constituents. In the simple case of gunpowder it is sufficient to find whether or no the solubility of the niter, in water, for instance, remains unchanged; but in the most complicated cases the principle remains the same. The condition of comparison at constant pressure (comparison at constant volume is impossible with solids and liquids) excludes air and such-like "mixtures of gases"; while whenever (as with arsenious sulphide and water) the change in chemical power is so slight as to remain in dispute, a discussion may arise as to whether the resultant "pseudo-solution" is to be classed with the solutions or with the mechanical mixtures—quite naturally, for at this point the two classes run into one another.

All this is simple and has proved important in practise; but being based on a view of solutions radically different from that of the texts under discussion, it can find no place in them.

The chemical compounds, or rather the substances so classed in the high school texts, may be grouped under three heads. First, silver chloride and other phases of invariable composition, which could be defined by adopting the "law" of combination in definite proportions as the definition of the group; second, water and similar bodies, which though not phases of invariable composition, can be "purified" by fractionation without paying special regard to the pressure at which the distillation is carried out; and third, a group of which sulphuric acid may be taken as the type. In the text books, the "chemical compound" sulphuric acid is described as "an oily liquid of s.g. 1.838 at 15° C."; it is in fact one of the continuous series of sulphuric acids—from dilute to fuming—used in the laboratory, and is thus not a phase of invariable composition; neither can it be "purified" by fractionation like water, while to include it among the chemical compounds because it freezes to a homogeneous solid of the same composition, would open the door wider than is consistent with general usage.

As a matter of fact, the name sulphuric acid and the formula H_2SO_4 were both introduced into chemistry without any special reference to the properties of this particular liquid, and would in all probability have won their way even if no substance of the composition H_2SO_4 could be prepared—such, at all events, was the case with the analogous "compounds" carbonic acid and ammonium hydrate. Formulas like H_2SO_4, H_2CO_3, NH_4OH and the names that go with them, are merely relics of one of the past attempts to represent symbolically the properties of solutions; in the old days, reagent bottles of sulphuric acid, whether concentrated or dilute, were labelled SO_3, then H_2SO_4 was substituted, and now, perhaps, $2\dot{H} + \bar{\bar{S}}O_4$, the symbol H_2SO_4 being retained with a different meaning. The change from one of these systems of formulation to another was due to a study of the properties of solutions as a class; can the text-books on their principles make this clear? Let us see how they deal with symbols.

The symbols HCl, $AgNO_3$, HNO_3 and AgCl are defined to give the compositions and, when known, the vapor densities of the compounds they represent. Following these definitions the symbol

$$HCl + AgNO_3 = HNO_3 + AgCl$$

purports to record what happens when

hydrogen chloride, the gas, and silver nitrate, the solid, are brought together. Perhaps the change represented would actually take place, if the conditions were favorable; let us assume that it would. Throughout the books, however, equations of this type are employed to represent reactions "in solution"; *i. e.*, in the case selected, when hydrochloric acid (a solution of the gas in water) is poured into an aqueous solution of silver nitrate.

Now, it is obvious that the use of symbols is just as legitimate in chemistry as it is in mathematics; and although an experienced analyst would attend to many matters not referred to in the symbol, would use rather more hydrochloric acid, and would expect to get rather less silver chloride than the quantities represented in the equation, yet considering its brevity the symbol gives a fairly accurate idea of the quantities involved, it is therefore of considerable practical use, and deserves careful explanation in the texts. No such explanation is offered, and indeed none is needed by those who regard solutions as mechanical mixtures; in their eyes the water has as little right to representation in the chemical equation as has the glass of the beaker in which the precipitation is made.

From such a starting point, however, a clear idea of the meaning of our present formulation of solutions is not to be reached; the high school treatment of ammonium hydrate and carbonic acid—discussions of the probability of "chemical combination" between ammonia and water, for instance, without first fixing the meaning of the term—only makes things worse; and in the end we find the children "believing" in ions, or "disbelieving" in hydrates-in-solution, just as a few years before they believed in fairies. The idea that our present method of formulating solutions is but a more or less imperfect symbolic representation of laboratory facts, will come upon them later, if it ever comes upon them, like the discovery that Santa Claus is but a kind thought; one experience of that kind ought to be enough.

Bacon says—I quote at second hand through Huxley—that "truth comes out of error much more readily than out of confusion," and Freeman, speaking of history, says that "the difference between good and bad teaching mainly consists in this, whether the words used are really clothed with a meaning or not." Is chemistry so different? Are vagueness and dodging really necessary in the text-books of our science? They are, so long as in the theoretical part the conception of continuity is negatived, while in the practical part experiments are described which have forced that conception into the science.

A change is unavoidable; but it is wholly unnecessary to give up the interesting chemical experiments for prosy disquisitions on water, ice and steam, or to fill the book with "How Old Is Ann" thermodynamical problems adapted from van Laar. Striking phenomena are as interesting to beginners to-day as they were a hundred years ago, but gradations too exist, and their existence must not be denied.

Until this change is made, children will be trained to accept obscure equivocal and dogmatic statements in place of clear and exact thought, and to be glib with words they do not understand. Such discipline, enforced in the name of science, of our science, far from ensuring the results prophesied by those whose efforts obtained for these new studies the place they now occupy in the schools, can hardly fail to injure pupil and teacher alike, depriv-

ing them of mental self-reliance and the power to weigh evidence and think clearly.

Unless a change be made, chemistry will surely earn a place among that group of pedagogic processes which Huxley strove so hard to have displaced, and which he characterized as the direct and preventible cause of most of the world's stupidity.

W. LASH MILLER

THE GENERAL ESSENTIALS IN TEACHING QUALITATIVE ANALYSIS

THE growing tendency to give more heed to the methods of teaching the natural sciences in the colleges has called forth the following generalizations regarding the second course in chemistry. The pedagogical aspects of the first course have been ably discussed by many teachers. The abundance of text-books on the second course, qualitative analysis, seems to indicate that every teacher follows his own notions and that no book is very generally satisfactory, all of which is unfortunate and perhaps unnecessary. There are, however, certain principles that seem to be regarded as essential by the majority of thoughtful teachers and an effort to present these principles appears to be worth while.

The main essential in conducting this course is to *teach qualitative analysis*. It is valuable and interesting on the side to learn many reactions, but only those reactions which are concerned in separations and identifications can be considered essential to the object in view. The study of other reactions is a study of general chemistry.

Opinions differ as to what introductory tests should be made by the beginner, but the above principle is successfully carried out when each individual substance (ion) is first subjected alone to the same reactions which it will undergo when present in a miscellaneous mixture under analysis. Such a parallel study of the members of a group will reveal to the intelligent student the possibilities of separation.

Secondly, *the procedure must be definite and explicitly stated*. Recent experimental studies in testing qualitative methods, particularly those of A. A. Noyes and assistants, have shown that the conditions of successful work must be carefully studied out for each step. Separations are very largely based on solubility differences, which is a quantitative matter; the directions must be devised with this in view and must be full enough to leave no room for doubt in the average mind.

Accordingly, it is essential, in the third place, that *the printed procedure be conscientiously followed in detail*. If varying conditions make it necessary to add more or less of a reagent in certain cases, the procedure should give information; but when a procedure has been worked out on the basis of elaborate qualitative and quantitative tests, as have some of our modern procedures, a pupil can not expect to get reliable results, if he follows his own untutored discretion. Analyzing from a memorized procedure is indeed likely to be a dangerous undertaking, since the memories of most young chemists will be liable to lead them astray as to the proper proportions or even the proper reagents. It is not to be understood that the procedure should be blindly followed, *e. g.*, with a false conscientiousness that would lead the worker to filter a solution when no precipitate was formed, but that those operations which are done should be conducted as directed.

In order that the pupil may be able to reproduce the proper experimental conditions for the tests, the pupil must be so carefully trained in the art and language of manipulation that he will have no difficulty in conducting the operations as the author intended.

A fourth essential is to *teach the bases of separation*. This is one of the most important and difficult tasks of the teacher, for much of the logic of the course is herein involved. By bases of separation are meant the differences in the physical and chemical behavior of substances which are utilized for the purpose of separation. These are the real "foundations of analytical chemistry." They should be clearly presented in the lec-

tures and must be elucidated and vigorously emphasized by the laboratory teacher.

It is in this connection that Dr. Benner's recent suggestion[1] is particularly valuable, viz., that the pupil should keep his test-tubes with their tests until the instructor can inspect them. If parallel tests are applied to the individual members of a group (which will be the case, if the preliminary drill consists as stated by the present writer in the third paragraph), the bases of separation can be pointed out on the test-tube rack. If the results of the tests are not preserved, the quizzing instructor must make use of the notes on these experiments or the pupil's memory of the results.

Many teachers think highly of the inductive method as a means of imparting an understanding of the bases of separation. The most consistent and extensive use of this method known to the writer was made in the University of Nebraska by Professor John White.[2] After the pupil has made a parallel study of the members of a group as to their behavior toward a series of reagents he is required to devise the procedure for himself. The principal merit of the plan is that it makes mechanical work impossible and teaches clearly the bases of separation. It needs to be closely supervised and the average instructor would regard it as too slow; moreover, the procedure devised by the best pupils must be discarded for the more perfectly developed procedure of the high-class modern manuals. The writer uses this inductive plan only in connection with the first group studied (silver group).

Fifthly, we must *teach the chemistry* (and some physics) *of the tests.* A recent canvass[3] has shown that many consider qualitative analysis invaluable as an agency for developing the pupil's knowledge of chemistry. Whether or not we wish to utilize qualitative analysis for this purpose, the knowledge of the chemical and some other phenomena involved in the tests is essential to an understanding of qualitative analysis. The pupil himself recognizes this as an attribute of a good course and he fully appreciates it when he finds himself learning his chemistry from experimental observation instead of from the book, much more truly than in general inorganic chemistry. The chemistry of the tests deservedly engages much of the teacher's attention during the major part of the course.

A sixth essential is to *cultivate self-reliance* from the start. The teacher and the procedure are not mated if the pupil is allowed to think that the procedure has many loopholes or pitfalls whereby the learner may be deceived. If the general procedure is really weak at any point, a supplemental note should appear in the procedure, dealing with the possible difficulties. Furthermore, the pupil must be encouraged to rely on careful work and to defend it against the teacher's suspicions. It may even be justifiable to approve a presumably incorrect report on a minor constituent rather than let a conscientious student have his faith in his work undermined, but the need of taking this measure should seldom arise. Recording the report of an unknown in ink in the note-book is a splendid means of developing reliable work. The pupil will seek to clear up all doubts before he commits himself to an unerasable report.

Self-reliant work by the pupil is quickly discouraged by any knowledge or suspicion that the instructor is guessing at the composition of an unknown. He must know exactly what the pupil ought to find, which means that the instructor's, or standardizing, analysis should be made by the same procedure as the pupil follows, since more delicate tests would sometimes give a positive result not yielded by another test. Any one who is familiar with qualitative laboratories must realize that in precision of instruction they average far behind the mathematics class-rooms or physical laboratories.

In the seventh place, *the pupil must be trained in the proper handling of a miscellaneous concrete substance* involving difficulties of dissolving and of detecting major and minor constituents. This is dealt with in the

[1] SCIENCE, N. S., XXXIII., 778.

[2] Compare White's "Exercises in Qualitative Analysis," Holt & Co., New York.

[3] *J. Am. Chem. Soc.*, XXXIII., 630.

writer's paper on "The Acquirement of Proficiency in Qualitative Analysis,"[4] which is based on letters from many teachers of qualitative analysis and leads to the conclusion that the intelligent handling of a miscellaneous qualitative analysis can best be taught in a subsequent course accompanying or following the course in advanced quantitative analysis.

HERMON C. COOPER

SYRACUSE UNIVERSITY

SURVEYS IN ALASKA

FOURTEEN parties of the Geological Survey, including about 50 men, are at work surveying and studying the mineral resources of Alaska. These parties are widely scattered over the territory and are doing work of many different classes.

One party is engaged in exploring Noatak River, in northwestern Alaska. north of the Arctic circle. This party, which is under the leadership of Geologist P. S. Smith, with C. E. Griffin as topographer, will make its way up Alanta River with canoes and hopes to find near the head of the river a pass across to the head of the Noatak and to descend that river to the Arctic Ocean at Kotzebue Sound. The region which will be traversed is unsurveyed and much of it is almost unknown.

A. G. Maddren is studying the geology and mineral resources of the extreme northeastern part of Alaska, north of Porcupine River. He is working in conjunction with a survey party of the International Boundary Commission.

Investigations of the water available for placer mining in the several camps of the Yukon-Tanana region, begun four years ago, are being continued this year. C. E. Ellsworth is engaged in this work in the Fairbanks and Birch Creek districts and E. A. Porter in the Fortymile district. These engineers made their way inland in the early part of April and began work as soon as the ice broke in the streams.

Two parties are continuing the reconnaissance mapping and study of the mineral resources of the Yukon-Tanana mining districts. One of them, which is under the charge of L. M. Prindle, assisted by J. B. Mertie, Jr., is working in the area known as the Circle quadrangle, which lies between parallels 64 and 66 and meridians 142 and 146. The other party, led by H. M. Eakin is in the Rampart quadrangle, an area covering about a degree of latitude between meridians 150 and 154. The preliminary mapping of these quadrangles, which include some placer districts, should be completed this year.

The region tributary to the Pacific seaboard of Alaska is the one which is now attracting most attention, because its mineral resources are being made available by railways. For this reason the surveys and investigations of this part of the territory are being energetically pushed by the Geological Survey. The province includes fields of high-grade coal and also copper and gold deposits, besides considerable arable land.

Two parties are at work extending the surveys in the southern part of the Copper River region, including the Hanagita Valley and the Bremner River basin. One of them, under D. C. Witherspoon, is making topographic surveys; the other, under F. H. Moffit, assisted by Theodore Chapin, is making geologic surveys and studying mineral resources.

A topographic base map of the Valdez Inlet mining district has been completed by J. W. Bagley. Mr. Bagley began work in April and continued until the middle of July, when he transferred his party to Kenai Peninsula and began a survey of the Moose Pass mining district. After completing this work he will begin the mapping of the Sunrise placer district.

R. H. Sargent, with a party of five men, landed at Kachemak Bay about June 1 and began mapping the western part of Kenai Peninsula.

G. C. Martin is engaged in studying the coal resources of the same region. Later in the season Mr. Martin will visit the Katalla oil field.

Kenai Peninsula has recently become the scene of some important developments in

[4] *J. Am. Chem. Soc.*, XXXIII., 630, April, 1911.

auriferous lode mining. B. L. Johnson is investigating the lode and placer deposits of the northern part of the peninsula.

The Yentna placer district lies about 150 miles north of the head of Cook Inlet. A topographic base map of this region was made some years ago, and a study of its geology and mineral resources is now being conducted by S. R. Capps.

A. H. Brooks, the geologist in charge of the Alaska surveys and investigations, will sail from Seattle for Prince William Sound on August 15. He will visit the lower Copper River region and the Valdez Inlet mining district and will spend some time on Kenai Peninsula.

THE BRITISH CENSUS

THE preliminary report of the census of England and Wales has been promptly made public. According to an abstract in the *British Medical Journal* the enumerated population of the United Kingdom on April 2, 1911, was 45,216,665, distributed as follows: England, 34,043,076; Wales, 2,032,193; Scotland, 4,759,445; Ireland, 4,381,951. It thus appears that England contains over 75 per cent. of the population of the United Kingdom, Scotland rather more and Ireland rather less than 10 per cent., while Wales contains the remaining 4½ per cent. The absolute diminution in the population of Ireland, noted in previous intercensal periods, has continued in the last, but the proportional decrease (1.7 per cent.) is less than any recorded since 1851.

In England and Wales the population has increased from 32,527,843 to 36,075,269, a percentage increase of 10.9. This is the lowest rate of increase on record, the rates for the two previous decennia being 11.65 and 12.17 respectively. The rate of increase of population depends upon two factors: (1) the balance between births and deaths; and (2) the balance between outward and inward passenger movement. The net gain by excess of births over deaths was slightly higher than in the previous decennium (12.44 as against 12.39 per cent.), a result due to the counterbalancing of a large reduction on the birth-rate by a still larger reduction of the death rate. The loss by balance of passenger movement was nearly half a million persons as compared with about 68,000 in 1891–1901, and over 600,000 in 1881–91.

With regard to the counties in which there has been a considerable rise or fall in the population it appears that some of the highest increases occurred in counties immediately surrounding the metropolis; Kent, however, showed an increase of only 8.8 per cent. The distribution of population in urban and rural districts, respectively, and their relative changes in the last intercensal period are as follows: In 1901, the urban population of England and Wales was 77 per cent. of the total and the rural population 23 per cent. For 1911, the figures are 78.1 and 21.9. The rate of increase in rural districts has risen from 2.9 to 10.2 per cent., and the rate in urban districts has fallen from 15.2 to 11.1 per cent. It should, however, be noted that the rates represent an actual increase of 2,818,072 persons in the urban and of 729,354 in the rural districts.

There has been a great increase in the populations of some of the suburban towns and districts which, conveniently designated the "Outer Ring," make up Greater London. The following have increased their population more than 70 per cent. in the last ten years: Southgate (124.2), Southall Norwood (99.4), Ilford (89.6), Ealing (85.4), Finchley (78.2), Surrey Rural Parishes (75.1), Hendon (72.9) and Barnes (70.5).

The proportion of females to males (1,068 to 1,000) was the same as at the previous census, but when due allowance is made for the number of males absent on military service in South Africa in 1901, it is probable that the true proportion of females to males was somewhat lower in 1901 than in 1911. The sex distribution varies considerably in different parts of the country, the proportion of females being lowest in Monmouthshire (912 to 1,000) and the highest in Sussex (1,218 to 1,000).

Three metropolitan boroughs show a percentage increase in population of more than

10, namely, Wandsworth (+ 34.3), Lewisham (+ 26.2) and Fulham (+ 11.7). On the other hand, six show a decrease of more than 10 per cent., namely, City of London (— 27.0), Holborn (— 16.9), Finsbury (— 13.3), City of Westminster (— 12.4), St. Marylebone (— 11.3) and Chelsea (— 10.1). Only one constituent of London's "Outer Ring" actually decreased in population, namely, the urban district of Penge (— 0.6). The population in the rural part of the "Outer Ring" increased by 54,799, no less than 14,591 of this change being credited to the rural parish of Mitcham.

CHARLES OTIS WHITMAN[1]

THE corporation and trustees of the Marine Biological Laboratory record their great sorrow and loss in the death, on December 8th last, of Professor Charles Otis Whitman, for twenty-one years director of the Marine Biological Laboratory and virtually its creator. His connection with the laboratory began at the time when it was first located at Woods Hole and before it had achieved recognized standing; with untiring energy and enthusiasm he strove to make it a national center for research in every department of biology.

"The great charm of a biological station," he wrote, "must be the fullness with which it represents the biological system. Its power and efficiency diminish with every source of light excluded." To zoology, which was the only subject represented at first, he added botany and physiology, and, so far as he was able, made provision for all the newer fields and methods of biological investigation. But his breadth of sympathy was associated with exacting thoroughness. By his own careful and critical work, as well as by his appreciation of the fundamental problems of biology, he set a high standard for the scientific work of the laboratory.

If the laboratory was to be truly national, Professor Whitman believed that it must be founded upon the cooperation of individuals and institutions. He recognized the fact that common ideals must form the basis of such cooperation, and he sought to bring into close connection with the laboratory every person and institution that shared these ideals with himself. By his kindness, sincerity, generosity, and devotion to the laboratory, he called forth similar qualities in others, so that it has been peculiarly characteristic of Woods Hole that a spirit of mutual cooperation and service prevails.

Finally, Professor Whitman stood for the complete autonomy of the laboratory. Although much needed aid might have been had more than once from universities and institutions by surrendering the independence of the laboratory, he steadfastly and consistently refused to do this, maintaining that the laboratory must be left free to grow and develop as its own needs and the interests of science demand, and that its government must remain in the hands of those most interested in it. Though there was formerly much difference of opinion as to the expediency of this stand, we are now all agreed as to Professor Whitman's foresight and wisdom in this matter.

Catholicity, cooperation, independence—these are the ideals which Professor Whitman succeeded in making part and parcel of the Marine Biological Laboratory and which we count among our most cherished possessions.

Professor Whitman was the founder and for many years the editor of the *Journal of Morphology;* he founded the *Biological Bulletin* and the annual volume of *Lectures* from the Marine Biological Laboratory. He was at one time director of the Lake Laboratory, one of the first research institutions in this country. He rendered eminent service in universities of this and other lands. He contributed to the advance of science by research work of fundamental importance. Biology owes much to his high ideals, his generous enthusiasm, his rigorous criticism, but most of all to the enterprise which always lay nearest his heart —the Marine Biological Laboratory. Here, if it had been possible, he would gladly have spent his life; to this place his thoughts returned with longing after every absence; to this place friends bore his body and laid it to

[1] Resolution prepared by Professor Edwin G. Conklin, and adopted by the corporation of the Marine Biological Laboratory on August 8, 1911.

rest almost within sight of the laboratory which he greatly loved, and which is his enduring monument.

SCIENTIFIC NOTES AND NEWS

Dr. R. W. Wood, professor of experimental physics at the Johns Hopkins University, has been elected a corresponding member of the Royal Society of Sciences of Göttingen.

During Dr. T. C. Mendenhall's recent visit to Japan, where he held the chair of physics in the Imperial University from 1878 to 1881, the Emperor bestowed on him the decoration of the Sacred Treasures, 2d class, and the National Educational Society conferred on him its gold medal.

At the recent centenary celebration of the University of Breslau, an honorary degree was conferred upon Dr. Theobald Smith, professor of comparative pathology at Harvard University.

The Royal Statistical Society of London has awarded a Guy medal in gold to Mr. G. Udny Yule.

Dr. Edward Schäfer, professor of physiology at Edinburgh, has been elected a member of the Imperial Academy of Sciences at Halle.

The Imperial Academy of Japan has awarded a medal and testimonial to Dr. Kimura for his discovery of the term in the variation of latitude known by his name.

Professor A. A. Michelson, head of the department of physics at the University of Chicago, has been the exchange professor at the University of Göttingen during the summer semester of 1911.

Among Americans who had expressed their intention to be present at the meeting of the British Association beginning this week in Portsmouth are: Professor Cleveland Abbe and W. J. Humphreys, U. S. Weather Bureau; Professor Carl Barus, Brown University; Professor A. A. Michelson, the University of Chicago; Professor F. W. Clarke, U. S. Geological Survey; Professor J. W. Spencer, Washington; Professor H. Webster, University of Nebraska; Dr. A. Goldenweiser, Columbia University; Professor H. C. Cowles, University of Chicago, and Professor A. A. Noyes, Massachusetts Institute of Technology.

Provost Edgar F. Smith, of the University of Pennsylvania, is on his way to Europe as the representative of his university at the celebration of the five hundredth anniversary of the founding of the University of St. Andrews in Scotland and the one hundredth anniversary of the founding of King Frederick University in Christiania, Norway. By August 17 he hoped to reach the University of Göttingen in order to celebrate on that day the thirty-fifth anniversary of his receiving the degree of doctor of philosophy at this university.

Dr. L. H. Bailey, whose resignation as director of the New York State College of Agriculture was announced last month, states that he will remain at Cornell until his successor is chosen.

Mr. F. W. Taylor, of Denver, has been appointed director of agriculture in the Philippines.

Dr. Fitting, associate professor at Halle, has been appointed director of the Hamburg Botanical Institute.

It is announced in *Nature* that Mr. C. E. Adams, of the Department of Lands, New Zealand, has been appointed astronomical observer at Wellington in succession to Mr. T. King, who has resigned. Mr. T. Southwell, scientific adviser to the Ceylon Company of Pearl Fishers, Ltd., and inspector of pearl banks, Colombo, has been appointed deputy director of fisheries, Bengal.

Mr. Arthur A. Allen, instructor in neurology and vertebrate zoology in Cornell University, will spend the next year in South America as chief of an expedition organized by the American Museum of Natural History. The expedition will go to Colombia, its immediate object being to explore ruins and collect antiquities.

The death is announced of Dr. Frank P. Foster, for more than thirty years editor of

the *New York Medical Journal* and prominent for his contributions to medical organizations.

THE death of Dr. Charpy, professor of anatomy at the Faculté de médecine de Toulouse, is announced.

THE U. S. Civil Service Commission announces an examination to fill a vacancy in the position of metallurgical chemist in the Bureau of Mines, for field duty, at a salary of $3,000 per annum.

WE learn from *Nature* that the geological and archeological collections made by the late Rev. E. Maule Cole, all the objects of which are connected with East Yorkshire, have been presented to the Hull Municipal Museum by Lady Philadelphia Cole.

THE third National Conservation Congress will be held in Kansas City, September 25, 26 and 27, 1911. The general objects of the National Conservation Congress as set forth in its constitution are (1) To provide for discussion of the resources of the United States as the foundation for the prosperity of the people. (2) To furnish definite information concerning the resources and their development, use and preservation. (3) To afford an agency through which the people of the country may frame policies and principles affecting the conservation and utilization of their resources, to be put into effect by their representatives in state and federal governments.

THE seventh International Esperanto Congress began at Antwerp on August 21 with 1,700 delegates, including 60 from America. The U. S. departments of state, war and commerce are represented, respectively, by Edwin C. Reed, secretary of the Esperanto Association of North America; Dr. H. W. Yeamans, vice-president of the American Association, and E. C. Kokeloy. Dr. Yeamans, who was president of the sixth congress, held in Washington last year, opened the convention. One of the features of the first session was the ovation accorded to Dr. Ludwig L. Zamenhof, of Poland, the inventor of Esperanto, when the Spanish consul presented to him on behalf of King Alfonso the Cross of the Order of Isabella.

THE *University of Chicago Magazine* gives some details in regard to the Otho S. A. Sprague Memorial Institute which was organized early in 1911, and is supported by a fund donated by Mr. Otho S. A. Sprague, for many years a resident of Chicago, who died two years ago in California. The donor designated his brother, A. A. Sprague, his own son, A. A. Sprague, 2d, and Messrs. A. C. Bartlett, J. P. Wilson, Charles L. Hutchinson, Byron L. Smith, Martin A. Ryerson, and Dr. Frank Billings as trustees of the fund. The directors have decided upon medical research as the chief object for which the income of the fund shall be expended, and have elected H. Gideon Wells, associate professor of pathology in the University of Chicago and Rush Medical College, to direct the research in medical problems. The work will be done in cooperation with existing institutions, namely, the University of Chicago, Rush Medical College, the Presbyterian Hospital, and the Children's Memorial Hospital of Chicago. The institute will command a definite number of beds in the Presbyterian Hospital for the study of any disease under investigation. An advisory council has been appointed, consisting of Dr. Frank Billings, Professor E. R. Le Count, Professor Ludvig Hektoen, head of the department of pathology and bacteriology, Dr. James B. Herrick, Edwin O. Jordan, professor of bacteriology, Dr. Joseph Miller, and Professor Julius Stieglitz, of the department of chemistry. Dr. Wells has already organized his force of workers, in the laboratories of the University of Chicago and Rush Medical College, and work is already under way. Among those already appointed members of the research staff are Dr. R. T. Woodyatt, Dr. Evarts Graham, Mr. H. J. Corper and Miss Maude Slye. At an early date also several fellowships will be awarded to provide for investigation in various problems concerning human health and disease.

STATISTICS compiled by the U. S. Geological Survey show that the production of spelter or metallic zinc from ore for the first six months of 1911 was 140,196 short tons, a gain of more than 5,000 tons over half the

record output of 1910. Of this production, 5,135 tons were made from foreign ore. Spelter stocks were reduced from 23,232 tons to 17,788 tons. Imports remained about the same but exports were nearly double those of half the preceding year. The apparent consumption of spelter was 135,497 tons, an increase of more than 12,000 tons over the half of 1910 but about the same as in half of 1909. The average price of spelter at St. Louis for the period was 5.36 cents per pound, the London average being .2 cent less per pound. During the latter part of May and the first part of June the average London price was about .1 cent higher than the corresponding St. Louis prices. Under this stimulus the May exports of spelter, zinc ore and dross were largely increased over those of the preceding months.

The *Electrical World* states that the Danish government, under the direction of its biological department at Copenhagen, has undertaken to aid the fishermen of the Baltic Ocean by preventing the migration of eels from that arm of the sea into the outer ocean. The means employed is a barrier of light, formed by placing fifty electric lights along a submerged cable between the island of Fano and the coast of Funen. The eels migrate only during the dark hours, and, accordingly, as soon as darkness begins in the season of migration the lamps are illuminated and a wall of light is thus interposed which the eels are fearful of passing. A similar plan, using submerged lamps, is said to be a favorite resort of Italian fishermen to keep eels from leaving the shallow waters.

The account in the July issue of *Man*, by Miss A. C. Breton, of some of the museums of archeology and ethnology in America, will excite among British students of these sciences mingled feelings—admiration at the enterprise and liberality of the American people, and regret that the contrast between the institutions of America and those in England is so clearly to our disadvantage. The museums described in this paper are the New York Natural History Museum, the Brooklyn Institute, the Peabody Museum of Harvard College, the Yale University Museum, the Philadelphia Academy of Sciences, the National Museum at Washington, and the National Museum of San José, Costa Rica. Practically all these representative collections are provided with suitable buildings and adequate staffs; each has its library, to which access is readily permitted, and arrangements are made by which the officials usually spend part of each year in field work, and are thus in a position to supply to inquirers first-hand information.—*Nature.*

It is stated in *Nature* that the Royal Commissioners for the exhibition of 1851 intend to put into operation at an early date a scheme of industrial bursaries. The scheme is as follows: The commissioners propose to establish a scheme of industrial bursaries for young men who, after a course of training in a university or approved technical college, desire to enter engineering, chemical, or other manufacturing works. The bursaries are intended to enable suitable applicants to tide over the period between their leaving college and obtaining remunerative employment in industry. The value of the bursary will depend on the circumstances of the candidate, but will, as a rule, not exceed £100 a year. A bursar will be elected in the first instance for one year, but the tenure of his bursary will ordinarily be prolonged for a second year provided that the commissioners are satisfied with the work done by the bursar during his first year. In special circumstances a bursary may be renewed for a third year. The appointments to the bursaries will be made by the commissioners from among candidates recommended by the authorities of certain selected universities and technical schools. In dealing with these recommendations, great weight will be given to evidence that a candidate has the practical abilities likely to lead to his advancement in manufacturing work, academic success alone being an insufficient recommendation. The candidate must be a British subject under the age of twenty-five. The candidate must have been a *bona fide* student of science for a term of three years. The candidate must further sat-

isfy the commissioners (*a*) that he has obtained, or can within one month of election obtain, a post in some engineering or other manufacturing works approved by them; (*b*) that he is in need of pecuniary assistance to enable him to accept such a post. A bursar may, if the commissioners approve, spend part of the tenure of his bursary in studying a special industrial process or processes in works either at home or abroad. No bursar shall enter a firm as a premium pupil without the special consent of the commissioners. A bursar must submit a report of his work to the commissioners on the expiration of each year of his bursary. Forms of application may be obtained from the secretary to the commissioners.

UNIVERSITY AND EDUCATIONAL NEWS

By act of the New York legislature, approved by Governor Dix, a state college of forestry has been established at Syracuse University, and the sum of $55,000 has been appropriated for it. It will be remembered that the legislature several years ago refused to continue to support the college of forestry at Cornell University.

Governor Dix has vetoed the bill to appropriate $10,000 for establishing a state school of sanitary science and public health at Cornell University.

Mr. Will C. Hogg has stated that he has assurances of a fund of $25,000 a year for five years for the University of Texas, from which a prize of $10,000 and other prizes are to be given for the best theses on the scope and purposes of the university.

At West Virginia University E. D. Sanderson, dean of the College of Agriculture, has been appointed director of the Experiment Station to succeed J. H. Stewart, recently resigned, to take effect January 1, 1912, in addition to his duties as dean. Mr. I. S. Cook, Jr., of Chilicothe, Ohio, a graduate of Ohio State University, 1906, has been appointed associate professor of agronomy. William H. Alderman recently associate horticulturalist, New York Agricultural Experiment Station, Geneva, New York, has been appointed professor of horticulture.

Dr. Robert Retzer, assistant professor of anatomy in the University of Minnesota, has been elected to a similar position in the University of Chicago.

Dr. Paul J. White, '06, assistant professor of farm crops in the New York State College of Agriculture since 1908, has accepted a professorship in Washington State College at Pullman.

Mr. Sidney S. Schmidt, a graduate of the Missouri School of Mines, and at present a chemist for the Washoe Smelter at Anaconda, Montana, has been appointed assistant in mineralogy at Northwestern University. He will take the place of Mr. A. J. Ellis, who resigned to accept an appointment on the U. S. Geological Survey.

Professor Reichenbach, of Bonn, has received a call to succeed Professor von Esmarch as director of the Hygienic Institute at Göttingen.

Dr. Gustav Störring, professor of philosophy at Zurich, has been called to Strasburg.

Professor Bethe, of Strasburg, has accepted a call as professor of physiology at Kiel.

DISCUSSION AND CORRESPONDENCE

COAL NEAR PINEDALE, NAVIJO COUNTY, ARIZ.

In Mr. A. C. Veatch's recent article on the coal deposits near Pinedale, Navijo County, Ariz.,[1] his first sentence reads: "The suggestion that there were coal deposits in the region near Pinedale, Ariz., first came to the survey through the General Land Office (about November 27, 1909)."

The writer wishes to call attention to the fact that coal was known to exist in this region many years previous to the date above given. In 1903 the writer published an article on the "Geology of the Fort Apache Region,

[1] U. S. Geol. Survey Bulletin No. 431—B. Advanced Chapter from Contributions to Economic Geology, 1909—Coal and Lignite, pp. 154–158.

Arizona";[2] and, in said article, the Cretaceous formation receives mention as follows:[3]

The Cretaceous.—About twenty-six miles northwest of Fort Apache near Forestdale (not far from Pinedale mentioned in the article above) a coal outcrop is exposed, which seems on lithological grounds, to be the same as the Fort Union or Laramie coal of New Mexico. The extent of this coal series is not known to the writer as it is almost everywhere covered with later deposits.

ALBERT B. REAGAN

NETT LAKE, MINN.

THE SECOND RECORD FOR BLANDING'S TURTLE IN CONCORD, MASS.

As curator of the Thoreau Museum of Natural History, Middlesex School, Concord, Mass., I have just received a specimen of Blanding's turtle [*Emys Blandingii* (Holbrook) Strauch] caught by W. A. Patch on July 19, 1911, in the Concord River, off Dakin's Hill. The specimen was given me by Mr. John Hoar, and is peculiar in that it has a large growth beneath the chin. The only other Concord record is of a specimen taken by Thoreau in the same river, and now (only carapace and plastron) preserved (No. 454) in the Boston Society of Natural History.

R. HEBER HOWE, JR.

SCIENTIFIC BOOKS

The Biological Stations of Europe. By CHARLES ATWOOD KOFOID. United States Bureau of Education; Bulletin, 1910, No. 4. Pp. 360. Washington.

The biologist of sixty and seventy years ago labored under difficulties that the present generation can hardly appreciate. The facilities for work were scarce; books and apparatus of all sorts were hard to obtain; there were no laboratories of any kind with the exception of the dissecting rooms of the medical schools. Little was known of methods of study of marine life. To be sure, one could wander along the shore, picking up the forms living between tides, and could preserve them in a bottle of new rum, but for the species living below low-water mark the student and collector had to depend upon the wreckage thrown up by storms or upon the contents of the stomachs of fishes. The latter method was employed by Dr. Stimpson in obtaining the material for his work upon the shells of New England, and, while looking over fish refuse for this purpose, was stoned as a crazy man by the boys of Marblehead. It was not until a few years later that the late Dr. Henry Wheatland, of Salem, constructed the first naturalist's dredge ever used in America and initiated Stimpson into a line of work which he turned to such good account while acting as naturalist of the Ringgold-Rogers expedition to the North Pacific Ocean.

The student of to-day has everything ready at hand. From the moment he enters the laboratory as an undergraduate until his doctor's dissertation is accepted, everything he needs in the material line is placed before him —specimens, books, apparatus—and all of his time and all of his energies can be devoted to his problem. Then when he goes to the shore for his investigations he is no longer compelled, like Johannes Müller, the father of marine biology, to depend upon the limited facilities of a fisherman's hut. He finds, in almost every region of the globe, a biological station equipped with every requisite for his work. In the evening he states his needs for the next day—animals, apparatus, chemicals —and the next morning he finds these ready in the well-equipped study set aside for his exclusive use.

Whether this is best in every respect for the student is a question. It is often remarked that the younger men have no such acquaintance with the animals and plants, their systematic position, names and habitats, that the older men had, and this lack of knowledge of one aspect of nature is in large measure due to the lack of any necessity of hunting the specimens. A little less helpfulness on the part of the laboratory collector would result in a better acquaintance with life and living things.

Be this as it may, the fact remains that biological stations are with us and they are

[2] *American Geologist*, Vol. XXXII., pp. 265–308.

[3] *Ibid.*, p. 280.

bound to stay and to increase in number and in extent of the facilities they afford. Already there are about a dozen permanent laboratories located upon our two coasts, while there are several more upon our inland waters. But it is in Europe that these stations have their greatest development, and it is of these that Dr. Kofoid has given a most valuable account.

The arrangement of his book is geographical and quite naturally begins with the celebrated Stazione Zoologica of Naples, despite the fact that the station at Concarneau (France) was the first permanent laboratory to be located on the shore (1859). Then follow, in order, the laboratories of France, Great Britain, Germany, Austria-Hungary, Scandinavia, Holland, Belgium, Spain, Finland, Russia and Bulgaria. Of each a history is given, usually illustrated with photographs and plans, of great value to all who have to do with the planning, equipment and management of biological stations in any part of the world. The volume will also be of great use to those who wish to avail themselves of the facilities of these stations, for it gives lists of the officials, conditions on which workers are admitted, lists of instruments and apparatus available, extent of libraries, and states whether price lists of specimens for sale are issued.

Especially valuable to all who have to do with laboratories, whether of biological stations or of our high schools and colleges, are the notes upon aquaria and the different methods of their construction, the pumps, tubing, valves and tanks of the water supply, and the different methods of aerating water and the rearing of larvæ and other forms. Thus we are told the composition of the Naples aquarium cement (equal parts of whiting and red lead, made into a stiff putty with boiled linseed oil) and the value of the "mastic de Cette," used for the same purpose.

In connection with many of the stations a statement is made of the annual expenditure within recent years, from which we learn that the running expenses of the Naples station are about $40,000; Helgoland, $18,000; Plymouth, $15,000; the Helder, $10,000, and so on down to Concarneau and Bergen with a budget of $1,500 each and Port Erin and Wimereux with a little over $1,000. Others probably have even less.

In all about eighty marine and fresh-water stations are described, many of them from personal knowledge on the part of Dr. Kofoid, and others from the publications. Besides there are accounts of other institutions which are not laboratories of the same type, but, like the Challenger office, are connected with the investigation of marine life and other problems of oceanography, or like the various fisheries bureaus, are concerned with economic problems. A good bibliography, to which references are made in the text, concludes the volume. J. S. K.

Charts of the Atmosphere. By Abbott Lawrence Rotch and Andrew H. Palmer. New York, John Wiley & Sons. 1911. Oblong 4to, cloth.

More than half a century ago Lieutenant Maury, of the United States Navy, rendered an invaluable service to mariners by his extended observations of ocean currents. The work which he began is still being carried on, with the result that from year to year new knowledge is gained concerning those aids and hindrances to navigation.

We now have in aerial research something analogous to the marine work of Maury.

In 1885, Abbott Lawrence Rotch—now professor of meteorology in Harvard University—founded the Blue Hill Meteorological Observatory. This is situated on the summit of a hill a few miles south of Boston and is 625 feet above sea level. The summit is less than eight miles from the coast line and is the highest elevation, so situated, between Maine and Florida. The observatory is a prominent feature in the landscape and may be seen eastward from Providence-Boston trains about fifteen minutes before reaching the latter city.

From the time of the foundation to the present, meteorological phenomena have there been continuously observed and recorded. The work still goes on.

From the beginning Professor Rotch realized that the elusive problems which ever con-

front meteorologists can only be solved by observations of the higher air.

In the early nineties the work of measuring the heights and velocities of clouds was begun. In 1894 the first systematic use of kites for carrying self-recording instruments to great heights was inaugurated at Blue Hill and in more recent years, under the auspices of the observatory, exploring balloons carrying instruments only have added much to the knowledge of the conditions which prevail above us.

In the earlier years of research at Blue Hill, the achievement of dynamic flight seemed to be in the dim and distant future, yet it was safe to assume that it would come in time and that when it came the aerial ocean must be charted.

We find a noble beginning of this new science in a recently published work, "Charts of the Atmosphere," written by Professor Rotch in collaboration with Mr. Andrew H. Palmer, one of his assistants at the observatory.

The charts are twenty-four in number, each being accompanied by full and clear descriptive text. The list is here given:

CHARTS

1. Relative Heights, Atmospheric Density and Temperature.
2. Average Temperature, Barometric Pressure, Wind-velocity and Pressure up to 30,000 Feet.
3. Maximum Wind-velocities and Pressure up to 30,000 Feet at Blue Hill.
4. Wind-pressures for Constant Velocities up to 30,000 Feet.
5. Wind-pressures for Constant Velocities up to 10,000 Feet.
6. Monthly Temperatures up to 12,000 Feet at Blue Hill.
7. Monthly Wind-velocities up to 12,000 Feet at Blue Hill.
8. Hourly Wind-velocities up to 10,000 Feet at Blue Hill.
9. Frequency of Constant Wind-velocities, 1,000 to 10,000 Feet at Blue Hill.
10. Frequency of Winds at Blue Hill, 650 Feet.
11. Velocity of Winds at Blue Hill, 650 Feet.
12. Frequency of Winds at Blue Hill, 1,650 Feet.
13. Velocity of Winds at Blue Hill, 1,650 Feet.
14. Frequency of Winds at Blue Hill, 3,300 Feet.
15. Velocity of Winds at Blue Hill, 3,300 Feet.
16. Frequency of Winds at Blue Hill, 6,600 Feet.
17. Velocity of Winds at Blue Hill, 6,600 Feet.
18. Frequency of Winds at Blue Hill, 10,000 Feet.
19. Velocity of Winds at Blue Hill, 10,000 Feet.
20. Wind-velocity and Direction up to 13,000 Feet at St. Louis.
21. Winds at Various Heights as Related to Barometric Pressure at the Ground.
22. Frequency of Winds in the N. E. Trade Region of the Atlantic Ocean.
23. Velocity of Winds in the N. E. Trade Region of the Atlantic Ocean.
24. Aerial Routes in Summer across the North Atlantic Ocean.

The author writes in the introduction: "The charts, which are believed to be the first of the kind adapted to the use of airmen, relate only to portions of the United States and the Atlantic Ocean, but they will doubtless be perfected by aerologists and extended in the near future to other parts of the globe."

Man ever seeks new lines of research and new regions to explore. So fascinating is the quest that it seems certain that Professor Rotch's expectations will be realized and that this work will be carried on by others in all parts of the world.

Even a brief study of this book of charts makes it clear that the work is the result of long-continued thought and of great labor. The various schemes of charting are brilliantly ingenious and original. It should be understood that these charts deal with the average conditions and not the actual ones which have to be faced on any given day.

The charts enable the aviator or aeronaut to foresee approximately the wind and temperature conditions that he will encounter aloft at any season of the year. With their aid the aviator may learn to what altitude he may safely ascend in regard both to his motor and to his bodily comfort, what winds are the prevailing ones for cross-country flight and at what levels they may be found.

The aeronaut may plan his journey from the wind charts, and in connection with a daily weather map go at will on either a long or a short excursion. Indeed, near the coast, it is shown that a free balloon may travel a

considerable distance inland on the sea-breezes and return with the opposite upper current to the coast within a few hours. For long balloon voyages, either trans-continental or trans-Atlantic, the charts are invaluable, showing, as they do, the level which the balloon should seek in order to obtain the benefit of the most favorable winds in respect to both direction and velocity, while other tables indicate the effects upon the passengers and upon the gas and motors.

The author does not mean to intimate that it is his belief that such balloon voyages will ever be of utilitarian value, but it does seem to him probable that the voyages would bring valuable data to the science of meteorology.

The reviewer would bespeak for Rotch and Palmer's method the most careful consideration of those engaged in this research work. There is a danger ahead. It is that in the strong and justifiable desire to be original the workers may follow diverse methods, making comparison and coordination of results extremely difficult, if not impossible, and thus labor may be wasted.

This is the day of "team-work," and only by such work can the aerial ocean be charted.

James Means

Principles of Physics. By W. F. Magie, of Princeton University. New York, The Century Co. 1911.

Within the past four months as many new college text-books in physics have appeared as in the preceding four years. New books by Carhart, whose earlier texts have had such wide success, by Magie of Princeton, Kimball of Amherst, Reed and Guthe of Michigan, and Hurst and Lattey of Oxford, Eng., added to the several good books already available, give college instructors a much wider range of choice for a suitable text for class use than they have had for many years.

Perhaps the most unique and original of the new offerings is that by Professor Magie, of Princeton University. Doubtless many teachers have felt that our common texts make too scant use of the historical development of physics in their presentation of its principles. The connection of related topics is often best brought out by showing how the emphasis of one in the scientific thought of a certain period, has led to discoveries in the other field. After reading such a book as Mach's "Mechanics" I have often longed for a text in general physics enriched with more of the historic evolution and the philosophy of the subject. But perhaps few of us would go as far as the author of this book does when he takes as a general principle "the progress of discovery has been along the line of least intellectual resistance and it is probable that what was easiest to discover once will now be the easiest to understand." This seems to assume that the attitude of mind of the pioneer in discovery is much like that of the student seeking to grasp the principles of a new science. But the one has the knowledge of what has been done in his branch of science to suggest further advance, the other must get his grasp on the new truth rather by relating it somehow to the facts of his own limited experience, else it will all seem unreal and bookish to him. The sophomore is not a scholar; he is little more than a boy and it is doubtful if the line of historic development will in every case give the best view-point for him. For a mature student or one who is seeking by a review of the subject to strengthen the foundations after a too hasty course in physics this book will be most suggestive, even inspiring. Professor Magie's method of treatment brings one into close relationship with the master minds who have given direction to the larger movements in scientific thought and such relationship is inevitably stimulating.

This historical point of view determines perhaps the unusually large proportion of the book devoted to mechanics and the properties of matter. This amounts to about 39 per cent. of the book. (The proportion found in four other recent texts by American authors averages 24 per cent.)

The use of the historical method doubtless explains also the relatively small attention given to the illustration of physical principles from modern machinery and industrial processes. To devote but a half page (p. 486) to

dynamo-electric machines and only a short paragraph (p. 495) to storage cells is very unusual in this day of devotion to the practical. The transformer seems scarcely to be mentioned.

An unusual feature of the book is the use of so-called "examples" to introduce important theorems and propositions to be proved. These are presented in groups at frequent intervals and are entirely different in character from the numerical examples usually given in college texts. Numerical examples of the ordinary sort are not wanting, but about 250 of them are given together at the end of the book as "exercises." (It would seem better to call the "exercises" examples and the "examples" exercises.)

The author justifies the use of a statical measure of force, the late introduction of the relation of heat to energy and the use of the method of rays in optics, on the ground that these are in harmony with his plan of following the historical order of development.

To sound and wave-motion even less than the usual proportion of space is given, only 6 per cent. of the book being allowed it.

The treatment of heat is decidedly satisfactory, the use of the historical method being particularly well adapted to this field. This is noticeable in the discussions of thermometry and of Carnot's cycle and the second law of thermodynamics. The absence of tables in the body of the text, characteristic of the whole book, seems a marked defect in this portion. There is scarcely any reference made to the small group of tables given collectively at the end of the book.

The discussion of light is marked by a complete separation of geometrical and physical optics, each receiving practically equal attention. The discussion of velocity of light is unusually brief and that of diffraction more extended than is common in college texts.

To electricity and magnetism rather less than the usual amount of space is given (24 per cent. as compared with 32 per cent., the mean of four recent texts). Magnetism and electrostatics are treated with relative fullness, but current electricity, and particularly electromagnetic induction, are too briefly discussed.

The many teachers who desire to see increased emphasis placed upon the historical development of physical thought, will follow the career of this book with special interest and hope that it may have a wide introduction.

A. D. Cole

A Text-book of Physics. By H. E. Hurst and R. T. Lattey. New York, Van Nostrand. 1910. $3.00 net.

This new text in physics comes from two Oxford University men. It is designed especially to fit students for the preliminary examination in Oxford Natural Science School. In carrying out this purpose a large number of examples are given, taken from actual examinations recently set at the universities of Cambridge, Oxford and London.

The book seems to be a combination of class text and laboratory manual. Too little attention is given to mechanics and the properties of matter are practically left out altogether. Universal gravitation and harmonic motion are other omitted topics. In the discussion of heat no treatment of the second law of thermodynamics, Carnot's cycle or the efficiency of heat engines appears. Light is presented in a very elementary way and wholly from the standpoint of geometrical optics. Interference, diffraction and polarization are not discussed at all and the treatment of spectroscopy is wholly from an elementary laboratory standpoint.

An undue amount of space—248 of the 610 pages of the book—is given to electricity and magnetism. (In contrast with this less than 100 pages are given to mechanics.) Here again some curious omissions may be noted. It seems particularly strange in an English text to find no discussion of Crookes's tubes, cathode rays, radioactivity or electrons.

The index is very incomplete and unsatisfactory. The illustrations, print, paper and general physical appearance of the book are good. The treatment of many important topics is so elementary and incomplete, and so many others are omitted altogether, that the

book would not seem to be well adapted for use as a class text in American colleges.

A. D. COLE

BOTANICAL NOTES

MORE ELEMENTARY BOTANY

FOR a long time there have been many school-men who have wished to unite the study of living things (plants and animals) into one subject, hence we have had "biology" in the curricula, and "biological" teachers, "biological" departments, as well as "biological" books. The present writer has not felt that such a fusing of two sciences is necessary, nor has he felt that it has ever been done successfully. In fact, the pupil in "biology" studies either *plants* or *animals*, unless he devotes himself to the few organisms that are on the border line between the two kingdoms, *e. g.*, the slime organisms (*Mycetozoa*), or the *Volvocineae*. This of course is never done. What is done is to take parts of the two related sciences, botany and zoology, and match them together in some fashion, and call the result "biology."

This is what has been done in the "Essentials of Biology," prepared by George W. Hunter (American Book Co., New York, 1911). In a prettily illustrated, well printed and well written book the author has attempted the impossible task of combining some study of plants and some study of animals into a consistent, single presentation. The botanical part of the book treats of flowers, fruits, seeds, roots, stems, leaves, forests, various forms of plants (only 13 pages), the modifications of plants, beneficial plants, relations of plants to animals, which is distinctly the old way of looking at plants. The zoological part begins with protozoa and takes up in succession worms, crayfishes, insects, mollusks, fishes, amphibians, reptiles, birds and mammals (and man). In the botanical part the pupil goes from higher plants to lower, while in the zoological part he goes from lower to higher.

There is much that is good in the botanical part, in fact the work seems to be good in the details, but the sequence is all wrong, and the author has been hampered by the attempt to unite into one, two totally different conceptions of living things—plants and animals.

Accompanying this book is another designed as a companion volume, entitled "A Laboratory Manual for the Solution of Problems in Biology," by R. W. Sharp, a colleague of the author of the "Essentials of Biology." Here the same criticisms hold as to the general plan of the book. However, in each chapter the work is well done, and no doubt the book will be helpful to many a teacher of botany and zoology.

A NEW MANUAL OF BOTANY

FOR so many years we have been accustomed to looking to the well-known botanical masters for general systematic manuals that we were surprised when we picked up Dr. George T. Stevens's "Illustrated Guide to the Flowering Plants of the Middle-Atlantic and New England States" (New York, Dodd, Mead & Co., 1910). The author has not been known to the botanical fraternity as one of their number, and there was doubtless some rubbing of eyes when the book first appeared. But an examination of the book shows that the author has a good acquaintance with the systematic botany of the portion of the country which his book covers and this gives him the right to add his book to the list of manuals we already have.

Opening it, one finds a pleasantly written preface in which we observe that "the classification adopted in this work is, in the main, that of Professor Adolph Engler in his Syllabus der Pflanzenfamilien." Further he says: "In the preparation of the work I have made use of my very large private herbarium, a collection which has been the work of many years, but I have had constantly before me the works of the latest German, French and English authorities and I have as constantly consulted the American works of Professor Wood, Dr. Asa Gray and that of Messrs. Britton and Brown." He gives especial credit to the work of Britton & Brown.

Before the descriptive portion of the manual is entered upon there are about fifty

pages of general matter covering the main facts of external morphology. The manual proper opens with a general synopsis of the flowering plants followed by an artificial key. Both of these are illustrated with many small figures. In the portion which is descriptive the usual treatment is followed and if one were to open the book at almost any page he would scarcely know that he was consulting a distinctly new book. The descriptions of species are considerably simplified, technical terms being rather rarely used. The species are illustrated rather fully, the illustrations being massed upon full-page plates which are interspersed among the pages of the text. These while rather roughly done are in many cases sufficiently good so as to constitute a good help especially for the student who is attempting to do the work by himself. The printing is good and the type well selected with perhaps the exception that here and there some portions of the type are quite too large and black. The species are partly decapitalized, capitals being retained only where the species is based upon a personal name. The introduction of the comma between the specific name and the name of the author is a backward step which we regret, but this can be corrected in a later edition. All in all the present reviewer is favorably impressed with the work which Dr. Stevens has accomplished, and there is no doubt that it will find a useful place in the literature of botany, especially for the non-technical student.

ROCKY MOUNTAIN BOTANY

In 1885 Professor John M. Coulter brought out a very handy manual under the title of "Manual of the Botany of the Rocky Mountain Region," and many of us by its aid identified the plants we collected in our occasional outings in the western mountains. Somewhat over a year ago a new edition was issued under the title "New Manual of Botany of the Central Rocky Mountains" (American Book Co., New York, 1909) under the joint authorship of John M. Coulter and Aven Nelson. From the preface we learn that the labor of revision (or rather of writing the new book) fell to Dr. Nelson, the accomplished professor of botany in the University of Wyoming. The area covered is practically the same as that attempted in the earlier edition, namely Colorado and Wyoming, the most of Montana, southern Idaho, eastern Utah, northern New Mexico and Arizona, with an eastern fringe including the Black Hills of South Dakota and the higher portions of the Great Plains.

The book has been modernized by the adoption of the Engler and Prantl sequence of families, and a nomenclature that conforms "as far as practicable" to that sanctioned by the Vienna Congress. Thus we have a moderate amount of decapitalization of specific names, and the consistent use of double citation of authors' names when necessary. In this connection we note with pleasure not only the citation of authors' names, but also in every case the citation of the original paper or publication in which the name first appeared. Of course in following the Vienna rules the author discards names which are identical for the genus and species, as *Taraxacum taraxacum*. The book has thus a vein of conservatism in spite of the fact that the author is fairly radical in the subdivision of some of the genera.

The handy summary shows that the author has "accepted" 2,733 species and 186 varieties in his treatment and regarded as synonyms of some of these 1,788 more, making a total of 4,707 "species" as they are regarded by some botanists.

The book will probably prove as useful to tourists and more serious collectors in the Rocky Mountain region as its predecessor, and both the earlier and the later authors are to be congratulated upon the new life of usefulness which will be accorded the new book.

BOTANICAL NOTES

Among recent papers may be noted the following:

"The Conditions of Parasitism in Plants," by D. T. MacDougal and W. A. Cannon (Carnegie Institution, 1910), discusses briefly dependent nutrition in seed plants, the root

habits and parasitism of *Krameria canescens*, xeno-parasitism (experimental production of parasitism), and the origination of parasitism, the latter a most suggestive philosophical discussion.

"Some Contributions to the Life History and Cytology of the Smuts," by B. F. Lutman (*Transactions Wisconsin Academy of Sciences*, 1910), adds materially to our knowledge of the development of these plants.

"A Catalogue of the Flowering Plants and Ferns of Connecticut," by a committee of the Connecticut Botanical Society (Geological and Natural History Survey, 1910), attempts to give "an accurate and authoritative catalogue of all the plants known to grow without cultivation in Connecticut," and it appears to have accomplished this purpose so far as the flowering plants and ferns are concerned. In the summary we learn that there are included in the catalogue 74 species of pteridophytes (all native) and 1,407 native spermatophytes, with 461 introduced species.

In passing we should notice favorably Wettstein's "Handbuch der Systematischen Botanik" (Leipzig, Franz Deuticke, 1910–11), a thick volume of over nine hundred pages. Seven great phyla ("Stamme") are recognized, viz., *Myxophyta* ("conventionally" placed here), SCHIZOPHYTA, ZYGOPHYTA (including *Peridinieae, Bacillarieae* and *Conjugatae*), PHAEOPHYTA, RHODOPHYTA, EUTHALLOPHYTA (including *Chlorophyceae* and *Fungi*) and CORMOPHYTA (including *Archegoniatae* and *Anthophyta*). The work will prove a most helpful one for the student of systematic botany, and merits translation into English.

CHARLES E. BESSEY

THE UNIVERSITY OF NEBRASKA

SPECIAL ARTICLES

ON THE STEREOTROPISM OF EMBRYONIC CELLS

IN a former paper, describing the development of nerve fibers in foreign media, the hypothesis was advanced[1] that the fibers require some form of solid support in order to carry out the growth process, which, as was shown, is a form of protoplasmic movement. The present communication presents in brief form the results of some experiments on the movement of embryonic cells, which show beyond doubt that the hypothesis holds true for the cells of the mesoderm and the medullary tube of the frog embryo. With reference to the outgrowing nerve fibers, however, the observations are too few to warrant any more definite statement about them at present.

In the previous experiments the solid support was given in the form of a fibrin network, derived from the clotting of fresh lymph. In the present study spider web was used to support the small pieces of transplanted tissue immersed in various fluid media. The object of the investigation being to compare the behavior of embryonic cells in the same medium, with and without solid support, two sets of preparations were made; one in which the tissue was placed in a simple hanging drop in a moist chamber, the other in which the drop was supported from below by a closely woven spider web. The moist chambers were made by sticking glass rings to object slides by means of vaseline and sealing to the ring a cover slip with the culture drop. The spider webs were tightly spanned over the upper surface of the glass rings prior to fastening the latter to the slide; the pieces of tissue to be studied were then transferred in very small drops of fluid to the web, and the preparations immediately covered by cover slips, also coated with the web, so that the pieces of tissue remained supported between two layers of the fabric.

The fluid media which were employed were purposely varied considerably; physiological salt solution, Locke's solution and Ringer's solution (without sugar) of full strength and diluted, and also defibrinated frog's serum, were all used. The best results were obtained with the defibrinated serum, but some positive results were obtained with all the inorganic solutions used, showing, in agreement with the work of M. R. and W. H. Lewis,[2] compatibility of wide range between tissue and medium.

[1] *Journ. of Exp. Zool.*, Vol. 10, 1910.

[2] *Anatomical Record*, Vol. 5, No. 6, June, 1911.

The results of the work are best typified in a single group of experiments which were made on May 21. Twelve embryos of *Rana palustris* were used and from each the whole neural tube with the adjacent mesoderm was cut out in a dish of saline. In each case the piece of tissue was divided into two parts and one half mounted in a simple hanging drop of defibrinated frog's serum, the other half in a drop of the same fluid held between two layers of spider web, as described above.

Of the twelve specimens in the first group, none showed any active cell movements during the first six days, and after that only one specimen, to be referred to below, manifested anything of the kind. In these specimens many cells became loosened from the main mass of tissue, remaining inactive and rounded, though the main mass itself remained alive and in a number of cases differentiated into striated muscle which exhibited frequent twitching.

Of the twelve specimens mounted between webs, eleven showed very active movements of the embryonic cells, which began even on the same day on which the preparation was made. Only one of these preparations gave negative results, and this was one that was injured by rough handling in mounting. The behavior of the cells in these cases is fundamentally different from that of the other cells in the simple drop without support, and the general appearance of the preparation is not unlike that of specimens isolated in clotted lymph, though there are some differences. Numerous cells extend from the main mass of tissue, sometimes singly, sometimes in masses. The cells are spindle shaped, branched or polygonal, with hyaline protoplasm in the processes and at the angles of the cells, the cell body being gorged with yolk granules. Careful focusing shows that the active cells are confined to two levels, viz., the under surface of the cover slip and the lower surface of the drop which rests on the layer of web spanned across the glass ring. Cells which are partly loosened between these two levels remain rounded and inactive, just as in the hanging drop preparations. In a very large number of cases the active cells are found to have definite relations to the web fibers. Often strands of spindle-shaped cells, resembling the cells of an embryonic tendon or the Schwann cells of a developing nerve, are found closely applied to slender bundles of web fibers. Again, spindle-shaped cells, sometimes with very long processes, lie in intimate contact with single web fibers. Where two such fibers cross, the cells may assume a tri- or quadripolar shape, with a process running along each fiber. Frequently the cells are closely attached to the cover slip and are then usually of flattened polygonal shape, forming in many cases extensive sheets. The cells may change their shape and move from place to place, or they may remain in one spot for days, practically unaltered in shape. After a few days typical pigment cells developed in a number of cases and these too assumed definite relations to the web fibers. In only two of the specimens were outgrowing nerve fibers observed. They were in all essentials like those previously found in the clotted lymph preparations, and in each case they crept along the lower surface of the cover slip, without definite relations to the web.

In this series of experiments the contrast between the preparations in the free hanging drop and those supported by web is so marked and so constant that it is impossible to escape the conclusion that the cells are able to execute their movements only when some solid framework is given them. The experiments in which saline solutions were used instead of serum bear out this same conclusion, though they are not so striking on account of a larger proportion of them giving negative results. The saline solutions are clearly not such good culture media as the serum, but notwithstanding this a number of specimens showed marked cell movement and remained alive for days.

Some of the experiments at first sight seemed to oppose the conclusion stated above, but on more careful study were found to afford a striking confirmation of it. This was brought out especially in a series cultivated in Locke's

solution, where the small hanging drop of saline frequently spread out and the tissue was left closely adherent to the cover slip. In two such cases, and in a similar one in which serum was used, cell movements took place, but the cells which exhibited movements were all in contact with the lower surface of the cover. One case showed nerve fibers. In another interesting case the drop of culture fluid was larger and touched the bottom of the chamber. The piece of tissue sank to the bottom and became adherent, sending out a number of short hyaline protoplasmic processes along the surface of the glass.

These and previous experiments show, then, that the movements of embryonic cells take place when the cells are in contact with a fibrin net, the fibers of a spider web or the surface of glass coverslips and slides, and that they occur in a considerable variety of fluid media. On the other hand when the embryonic tissue is suspended free in a drop of fluid,[8] no cell movement takes place, though differentiation of tissue may result. In this movement and orientation of the cells we have before us a form of stereotropism, of which, however, the exact nature remains for the present undetermined. Whatever it may prove to be, it can scarcely be doubted that it is an important factor in normal development, influencing the movement and segregation of pigment, mesenchyme and nerve cells at least, and probably also the growth movements of nerve fibers.

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[8] M. R. and W. H. Lewis (*op. cit.*) state that growth apparently takes place as well in fluid media as in solid, though they admit that the outgrowing cells often creep on the cover glass or the bottom of the dish. I feel confident that careful examination of specimens with reference to this point will show that the growing cells are always in contact with the glass, except that the surface film of the free hanging drop may sometimes act as a substitute for the solid surface, as I have occasionally found to be the case in a series of experiments with tissues of the chick embryo, to be described later.

ON THE INCREASE IN OXIDATION IN THE EGG AT THE BEGINNING OF DEVELOPMENT

IT was observed by O. Warburg that the oxidation in the sea-urchin's egg is increased when it is fertilized or placed in a hypertonic solution, which induces parthenogenesis. Warburg observed an increase in oxidation in the fertilized egg when placed in pure NaCl solution (which also causes parthenogenesis in the unfertilized egg), but in order to insure the life of the eggs long enough for the experiment he added a trace of NaCN to the NaCl (and to the control).

The addition of NaCN was objected to by Loeb and Wasteneys, who found no increase in oxidation if the cyanide was omitted. Apparently the cyanide, or hydroxyl ions liberated by hydrolysis, had something to do with the result. We found that NaCl increased oxidation in unfertilized eggs about one fourth.

We made similar experiments on unfertilized eggs using an isotonic NaCl solution containing the same hydroxyl ion concentration as the sea water (made by the addition of NaOH). The result was an increase in oxidation in the NaCl solution to double its rate in sea water. In other words, the NaCl solution in the presence of OH-ions causes an increase in oxidation in the unfertilized egg. This was found true also of another parthenogenetic agent.

Microscopic examination showed that the eggs formed "fertilization membranes" in the NaCl solution, and some of them that were returned to sea water after the close of the experiment segmented and produced cilia. In short, the NaCl + OH ions start development and the increased oxidation may be due to the same cause as the increased oxidation in the fertilized egg.

One of the authors has shown an increase in permeability of the egg to ions, at the beginning of development. He suggests that the NaCl solution causes an increased permeability of the egg to OH-ions, and that the latter penetrate the egg and accelerate oxidation. The morphological changes in the egg

may be the result of the increased permeability and oxidation. Perhaps the increased oxidation in fertilized eggs caused by alkaline NaCl is due to still further increase in permeability to OH-ions.

P. H. Mitchell
J. F. McClendon

Woods Hole, Mass.,
August 11, 1911

THEORIES OF ELECTRICAL DISCHARGE

The present attitude of the scientific mind on the one-fluid and the two-fluid theories is amusingly similar to the conditions in the early part of the last century concerning theories of light. The emission theory and the wave theory were both well known. Either could be held by any one who chose to do so. Either would serve as a means for explaining phenomena. The emission theory had the advantage. It had come down through generations from a revered source. There is such a thing as mental inertia. Fresnel and Young learned this. When they fully explained phenomena on the theory of transverse vibrations which could not be explained by the emission theory, it had little effect. They devised new experiments which could not be explained by Newton's theory. They explained the phenomena of Newton's rings on a rational basis. It all counted for nothing. Newton's followers might not be able to explain what it was that happened when light had a fit of easy transmission, or a fit of easy reflection. It was, however, evident that the fits were there, for Newton's rings gave evidence of it.

Every one will of course admit that the two-fluid theory has served a useful purpose. It has, however, also led us astray. It has led us to take a wrong view of phenomena.

When it is said, for example, that hot metals emit positive ions, the idea conveyed is very different from that which would be conveyed by the statement that hot metals take negative corpuscles from the gas molecules which surround them.

If one were to say that householders all over the country are emitting mail-carriers, the idea conveyed would be definite and very misleading. As a matter of fact they are receiving their mail. The mail-carriers simply bridge the gap between the conduction channels along the railways, and the householder.

Of course it is perfectly evident that positive ions such as exist in discharge through gases can not circulate or flow through a copper wire. They simply vibrate to and fro between the terminals. The copper wire is itself a solid aggregation of positive ions. The negative corpuscles pass in rhythmical transfer from molecule to molecule within the wire. All of the phenomena of the vacuum tube and of discharge across air gaps are merely incidental to the condition that at that point the conductor is in gaseous form. The Faraday dark space is simply a region in which molecules, supercharged in the region of negative glow, are urged away from the negative terminal, without appreciable interchange or transfer of the negative corpuscles from molecule to molecule.

The positive or luminous column is a region in which this transfer is going on. These two regions may exist side by side. A small windmill made of non-conducting material is then driven in opposite directions in the dark and the luminous columns. The luminous columns are simply "canal rays." The carriers are returning after having delivered all of their supercharge and part of their normal charge.

These dark and luminous regions may, under proper conditions, exist as striations. They are then electrically produced sound waves.

The positive terminal of an influence machine is an exhaust terminal. Negative corpuscles from the surrounding air are drained into it. A disruptive discharge can be made to end in such a drained region, as "sheet lightning," before the positive terminal is reached.

Every lightning discharge which has its terminals in air must at its positive end be a region of "sheet lightning." It is probably often at higher altitudes than the rain-clouds. The negative end is usually within the clouds, and that end is "forked lightning."

Papers which contain photographic evidence that seems conclusive and which leads to the above conclusions have been recently published by the Academy of Science of St. Louis. They give a rational explanation of older phenomena which had not been explained on the two-fluid theory. For example, why are positive and negative Lichtenberg figures so different in form? How are we to explain the arc-like form of discharges, shorter than the critical spark length? What is the critical spark length? An additional suggestion may be made.

Assume two spheres of mass m and m'. They attract each other with a force Kmm'/r^2. Assume that the spheres are connected by means of a flexible conductor, and that negative corpuscles are pumped out of, or forced into the two masses. A condition will be found for which the attraction between these two masses will be a maximum. If the number of corpuscles in the masses be then either increased or diminished, the attraction will be less. With small masses we can easily reduce the attraction to zero, or make it negative.

Why should we continue to say that in one of these cases we are adding positive electricity to these spheres, when we are all fully convinced that we are not?

The attraction in dynes between these masses of radii R and R' cm., and distant from each other r cm., the matter composing them having a density ρ is

$$A = \frac{RR'}{r^2}\left(\tfrac{16}{9}\pi^2\rho^2 KRR - V^2\right).$$

This force will be zero when

$$V = \tfrac{4}{3}\pi\rho\sqrt{K}RR',$$

where V is potential in electrostatic units. This last condition does not depend upon the distance of these bodies from each other (neglecting mutual induction), but upon the magnitude of the bodies.

For two bodies having the size of the moon and earth, assuming that they have a density $\rho = 5.5$, the potential must be raised to 1.96×10^{17} volts, in order that they shall cease to attract each other.

The last equation may also be written

$$K\rho^2 RR' = 9\,\sigma\sigma',$$

where σ and σ' are surface densities on the two bodies.

The interesting suggestions of Arrhenius in regard to the invasion of our atmosphere by corpuscular radiation, suggest that the actual potential of earth and moon are not widely different. While these considerations are perhaps of no astronomical significance, they nevertheless lead us towards a general conclusion which seems to have some interest.

May we not conclude that Newton's equation for gravitational attraction represents a special case, in which all of the molecules in both masses possess what might be called the normal number of corpuscles?

If one mass is in normal condition and the other is "charged" as above, Newton's equation also represents a special case, the discussion for which is apparent.

FRANCIS E. NIPHER

THE AMERICAN CHEMICAL SOCIETY. IV

DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

H. P. Talbot, *chairman*

S. L. Bigelow, *secretary*

The Mechanism of Reversible Oxidation and Reduction Reactions in Solutions: E. P. SCHOCH.

Electrolytic Formation of Aniline without a Diaphragm: E. F. FARNAU.

Electrolytic Corrosion of some Metals: G. R. WHITE.

The Vapor Density of Formic Acid as Affected by Changes of Temperature and Pressure: ALAN W. C. MENZIES and PAUL N. LEECH.

The Thermal Expansion of Solid Lithium and its Change of Volume on Fusion: ALAN W. C. MENZIES and R. K. BRODIE.

The Liquidus Surface for the Ternary System Composed of the Nitrates of Potassium, Sodium and Calcium: ALAN W. C. MENZIES and N. N. DUTT.

The Free Energy of Dilution of Hydrochloric Acid: R. C. TOLMAN and A. L. FERGUSON.

A method is described of determining the free energy of dilution of an electrolyte without employing cells that have liquid boundaries. Values of the free energy of dilution of hydrochloric acid

$n/10$ to $n/50$, $n/100$ and $n/500$ solutions are given. The values of the concentration of the ions and undissociated acid as calculated from these measurements are compared with the corresponding values of concentration as calculated from conductivity measurements. The discrepancies between the two methods of determining concentration are discussed.

Note on the Concentration of Hydrogen Ion in Sulphuric Acid: R. C. Tolman and L. H. Greathouse.

The results are described of an indicator method of determining the concentration of hydrogen ion in sulphuric acid. A suitable indicator is added to the solution of sulphuric acid in question and the color compared with that of a solution of a uni-univalent acid (HCl or HNO_3) to which the same amount of indicator has been added. By adjusting the concentration of the uni-univalent acid the concentration of a solution isohydric with the sulphuric acid can thus be found, and the concentration of hydrogen ion in this solution calculated from conductivity measurements.

Estimation of Degree of Ionization in Moderately Concentrated Solutions of Electrolytes: E. W. Washburn.

The Dissociation Relations of Cæsium Nitrate, Lithium Chloride and Potassium Chloride in Aqueous Solution at 0°: E. W. Washburn and D. A. MacInnes.

Diameters of Pores in Osmotic Membranes: F. E. Bartell.

Some Applications of the Electronic Conception of Positive and Negative Valencies: IV., Fluorescence: Harry Shipley Fry.

Action of Zinc-copper Couple on Bromoform: Wilder D. Bancroft.

Viscosity of Solutions of the Metal-ammonia Salts: Arthur A. Blanchard and Harold B. Pushee.

Ammonia when added to solutions of salts of alkali and alkaline earth metals causes slightly greater increase of viscosity than when added to pure water. Comparing this fact with the known fact that ammonia added to salts of silver, copper and zinc, causes a marked decrease in viscosity,[1] the conclusion is drawn that while the latter metals form more compact complex ions with ammonia than with water, the alkali and alkaline earth metals form more compact complex ions with water than with ammonia.

[1] Blanchard, *J. Am. Chem. Soc.*, 1904, **26**, 1315.

Some New Ammono Salts: E. C. Franklin.

Ammonates of Barium Trinitride: A. W. Browne and E. A. Rekate.

The 0° isotherm of the pressure-concentration diagram for the two-component system barium trinitride, ammonia, has been studied over pressures ranging from 0 cm. to 300 cm. Three solid ammonates were obtained, of the respective composition $BaN_6 \cdot NH_3$, $BaN_6 \cdot 2NH_3$ and $BaN_6 \cdot 8NH_3$. Under certain conditions a curious reluctance was observed, especially on the part of the lower ammonates, either to take up or to give up ammonia.

Ammonated Ammonium Trinitride: A New Hydronitrogen: A. W. Browne and A. E. Houlehan.

Pressure-concentration isotherms at —33°, 0° and 20° have been studied for the two-component system hydronitric acid, ammonia, over a range of pressures from 0 cm. up to about 175 cm. At the two higher temperatures no indication of the formation of an ammonated ammonium salt was obtained. At —33°, however, a diammonate of the formula $NH_4N_3 \cdot 2NH_3$, or N_6H_{10}, was obtained. This substance was obtained in the form of clear, colorless, somewhat elongated plates, which at —33° are in equilibrium with solid ammonium trinitride and ammonia gas at a pressure of about 22 cm., and with its saturated solution and ammonia gas at about 42 cm. At —33° one gram of liquid ammonia dissolves one and nine tenths grams of the diammonate. At 0° one gram of liquid ammonia dissolves nearly one gram of the "anammonous" ammonium trinitride.

Throughout the research a specially constructed glass apparatus was employed by means of which it was possible accurately to measure the amounts of ammonia introduced into the system or withdrawn from it.

Behavior of Certain Metals in a Liquid Ammonia Solution of Ammonium Trinitride: A. E. Houlehan.

Weighed amounts of ammonium trinitride were dissolved in liquid ammonia and were brought into contact, in a specially constructed nitrometer, with weighed amounts, respectively, of metallic lithium, sodium, potassium, magnesium, calcium, zinc, aluminum and tin. The first five metals acted vigorously, liberating hydrogen quantitatively from the hydronitric acid, and forming the corresponding metallic trinitride. Zinc acted very slowly, and aluminum and tin did not act at all.

With non-metals, such as sulphur, phosphorus and iodine, no action was observed.

Ammonolysis of Certain Hydrazine Salts: A. E. Houlehan.

The behavior toward liquid ammonia of several hydrazine salts has been studied in a specially designed extraction apparatus. It was found that the monosulphate, disulphate, dioxalate and diselenate of hydrazine readily ammonolyzed, yielding the corresponding ammonium salt and free hydrazine, but that the monophosphate and the diphosphate did not ammonolyze.

Aluminum Anodes in a Liquid Ammonia Solution of Ammonium Trinitride: M. J. Brown and G. W. Pawel.

Aluminum anodes were corroded in a liquid ammonia solution of ammonium trinitride, with formation of a grayish scale. This substance was filtered and was washed with pure liquid ammonia in an apparatus designed to exclude all moist air, and to permit the proper sampling of the product. The purified substance, when brought into contact with water, became red hot and decomposed, yielding aluminum hydroxide, ammonia, hydronitric acid, nitrogen and hydrogen. Repeated analysis has shown it to consist, in all probability, of a partially ammoniated aluminum nitride mixed with a small percentage of an ammonobasic aluminum trinitride. This is considered to have been formed by an initial "nitrination" of the metallic aluminum by the discharged nitrine ions, and subsequent ammonolysis of the aluminum trinitride formed. An accurate gasometric method for the determination of small amounts of hydronitric acid has been devised during the course of the research.

Oxidation of Arsenious and Antimonious Oxides by Means of Air and Water: J. Bishop Tingle and Volney A. Ray.

It is well known that arsenious and antimonious oxides (As_4O_6 and Sb_2O_3) are transformed easily, by many oxidizing agents, into arsenic and antimonic oxides (As_2O_5 and Sb_2O_5), but the authors have failed to find any record of the fact that this change can be brought about by the action of air and water.

The observations on which this conclusion is based were made in the course of some experiments having for their object the preparation of certain organic derivatives of arsenious and antimonious oxides.

The organic compound was mixed with a little alcohol and water, the respective oxide added and the mixture boiled in a test-tube which was fitted to a reflux condenser of small bore.

After about sixteen hours the liquid still had an odor of alcohol, but the oxides were found to have been converted into the antimonic and arsenic stages of oxidation.

Similar results were obtained by the use of the oxides, water and alcohol (99 per cent.) only, in the ratio 0.5 g., 5 c.c. and 3 c.c., respectively, but the boiling was continued during about 26 hours, at the end of which time the change was practically quantitative.

The Freezing-points of Liquid Sulphur when Soufre Nacre and when Rhombic Sulphur are Deposited: Alexander Smith and C. M. Carson.

Crystallized Calcium Tetrasulphide: William McPherson, H. Mougey and James R. Withrow.

The Detection of Traces of Copper: A. Guilllaudeu, Wesley B. Pritz and James R. Withrow.

The Precipitation and Separation of Arsenic Antimony and Tin: J. I. D. Hinds.

Reduction of Nitrobenzene by Ferrous Hydroxide: H. C. Allen.

The Action of Ammonia on Arsenic Halides (preliminary report): C. H. Herty.

"Nipponium": Charles L. Parsons.

A New Thermostat: Charles L. Parsons.

The Hydrolysis of Ethyl Barium Sulphate: W. A. Drushel.

The Action of Water on Apatites: F. K. Cameron and W. H. Waggaman.

Metallic Properties of some Organic Radicals: H. N. McCoy, F. L. West and C. H. Viol.

Preparation of Anhydrous Perchloric Acid: H. H. Willard.

Polyborates: C. L. Parsons and C. O. Brown.

The Solubility of Iodine and Potassium Iodide in the Presence of Each Other: C. L. Parsons and C. F. Whittemore.

Ozone: Harry N. Holmes.

The author of the paper reviewed the present technical uses of ozone such as water purification, ventilation by oxidation of "air sewage," bleaching, deodorizing, aid to cold storage, sterilization, organic synthesis and others. The cost of ozone as made by different methods was discussed.

The various methods of making this gas in the laboratory were enumerated and the author con-

sidered it quite probable, reasoning from the large number of instances in which the generation of oxygen is known to be accompanied by the formation of ozone, that whenever oxygen is released in the atomic or nascent state some of the atoms unite in threes to form ozone. The conditions such as temperature, presence of oxidizable material, etc., do not always permit a successful test.

Various theories of the formation of ozone in nature were given and the author cited recent experiments of his own attempting to throw light on the release of ozone by green leaves. This work and a study of the value of ultra violet light in the formation of the gas in outdoor air is to be continued.

A New Reagent for Potassium: L. L. BURGESS and O. KAMM.

The Effect of the Magnetism upon the Passive State of Iron and Nickel: HORACE G. BYERS and AGNES FAY MORGAN.

A New Method for the Separation of Cerium: C. JAMES and L. A. PRATT.

By boiling, a slightly acid or neutral solution of the rare earth oxides in nitric acid, with potassium bromate and marble in the lump condition, cerium is precipitated. The composition of the precipitate varies with the amount of potassium bromate used. With a slight excess of bromate, a basic ceric nitrate is obtained. If the excess of bromate is great, the precipitate contains quantities of the basic bromate.

When this method is carefully carried out, a very pure product of cerium results.

New Rare Earth Compounds: L. A. PRATT and C. JAMES.

The following salts were prepared while searching for some crystalline compounds which might be useful for fractional crystallization of the yttria earths:

Yttrium methyl sulphonate

$$Y[CH_3(SO_2)O]_3 \cdot 4H_2O$$

Yttrium methene disulphonate

$$Y_2[CH_2(SO_2O)_2]_3 + 2\tfrac{1}{2}H_2O?$$

Yttrium methine trisulphonate

$$YCH(SO_2O)_3 \cdot 3\tfrac{1}{2}H_2O$$

Yttrium camphor sulphonate

$$Y(C_{10}H_{15}O \cdot SO_2O)_3 \cdot 7H_2O$$

Yttrium salicylate .. $Y[C_6H_4(OH)COO]_3 \cdot 3\tfrac{1}{2}H_2O$

Yttrium phthalate .. $Y_2[C_6H_4(COO)_2]_3 \cdot 3H_2O$

Yttrium glycollate .. $Y(CH_2OHCOO)_3 \cdot 2H_2O$

Yttrium phenyl acetate

$$Y(C_6H_5CH_2COO)_3 \cdot H_2O$$

Yttrium phenoxy acetate

$$Y(C_6H_5OCH_2COO)_3 \cdot 3\tfrac{1}{2}H_2O$$

In addition to the above, the phenoxyacetates of samarium, neodymium, praseodymium, lanthanum and cerium were prepared.

A Convenient Apparatus for the Preparation of Anhydrous Hydrazine: C. F. HALE and F. F. SHETTERLY.

A convenient glass apparatus for the preparation of anhydrous hydrazine by the action upon hydrazine hydrate of any suitable dehydrating agent has been constructed. The action upon hydrazine hydrate (1) of barium oxide, according to the method of de Bruyn, (2) of barium hydroxide and (3) of sodium hydroxide, according to the procedure of Raschig has been studied under comparable conditions. As a blank experiment pure hydrazine hydrate has been subjected to fractional distillation in the same apparatus and under conditions similar to those prevailing in the other experiments.

Anhydrous Formic Acid: J. B. GARNER.

Action of Nitrogen on Lithium Carbide: S. A. TUCKER and H. R. MOODY.

Europium: C. JAMES and J. E. ROBINSON.

The material used in this work comprised the following: oxides from insoluble double sodium sulphates from about 200 kilograms of yttrium minerals; all the samarium and gadolinium oxides derived from about 200 kilograms of Brazilian monazite; and about 110 kilograms of oxides obtained from the more insoluble double potassium sulphates coming from very large amounts of Carolina monazite.

These crude oxides were converted into the double magnesium nitrates and fractionally crystallized in large porcelain dishes. The neodymium, lanthanum and praseodymium rapidly collected in the least soluble portion. The intermediate fractions consisted chiefly of the pale yellow samarium compound, while the most soluble portions were rich in gadolinium and were colored pink by the erbium metals. As soon as the crystals of the simple nitrates of the yttrium elements made their appearance, the isomorphous bismuth magnesium nitrate was added to the most soluble fraction. Upon further crystallization, all traces of samarium and europium were rapidly eliminated from these most soluble fractions and they were set aside since they contained only the yttrium earths.

The most insoluble fractions containing lan-

thanum, cerium, praseodymium and neodymium were separated from the series as soon as they were freed from all samarium. The larger portion of the samarium was gradually removed by a great number of crystallizations. At this point the fractions were transferred to porcelain casseroles covered with watch glasses, and the nitric acid, used as a solvent, was increased from thirty to fifty per cent.

As the work proceeded, the europium band was observed to become stronger in the fractions between samarium and gadolinium. After many ligatures, these middle fractions were found to contain only europium. These portions were dissolved in water, saturated with hydrogen sulphide, and the clear filtrate was treated with oxalic acid. The europium oxalate was then washed, dried, and stored for the study of its compounds.

DIVISION OF ORGANIC CHEMISTRY

Geo. B. Frankforter, *chairman*

Wm. J. Hale, *secretary*

Derivatives of Isocamphoric Acid: W. A. NOYES and W. T. MURDOCK.

Lauronolic Acid and Other Compounds of the Lauronolic Series: W. A. NOYES, C. E. BURKE and R. S. POTTER.

Decomposition of Nitroso Compounds in the Presence of Alcohols: W. A. NOYES and J. A. COSS.

The Acyl Derivatives of O-amino Thiophenol: J. H. RANSOM and L. D. HAMMOND.

The dibenzoyl derivative has been made and analyzed. The diacyl derivatives, in which the acyl groups C_6H_5CO and

$$C_6H_7\left\langle\begin{matrix}NO_2\\ m\\ CO\end{matrix}\right.,$$

were introduced in reverse order, have been made but not sufficiently purified for analysis. The saponification products of both appear to be the same, though the monoacyl derivative has not been identified with certainty.

The diacyl derivatives, in which the acyl groups, C_6H_5CO and $COOC_2H_5$, were introduced in reverse order, have been made and one of them purified and analyzed. The saponification products appear to be the same, *i. e.*, benzoic acid and an oil of characteristic disagreeable odor. Oil not yet purified, though it has the properties of a monoacyl urethane.

Likewise there have been introduced, in reverse order, the groups

$$C_6H_7\left\langle\begin{matrix}NO_2\\ m\\ CO\end{matrix}\right.$$

and $COOC_2H_5$, but these derivatives have not been wholly purified. The saponification products appear to be identical, and the monoacyl derivative the disagreeable smelling oil above mentioned.

The anhydro base

$$C_6H_7\left\langle\begin{matrix}S\\ N\end{matrix}\right\rangle C\cdot C_6H_7NO_2$$

has been prepared and analyzed and a substance having the composition of the substance

$$C_6H_7\left\langle\begin{matrix}S\\ NH\end{matrix}\right\rangle C\left\langle\begin{matrix}OH\\ OC_2H_5\end{matrix}\right.$$

though this may be the disulphid due to oxidation of the mercaptan hydrogen.

The work will be extended and completed.

Ethyl Cyantartronate and its Addition Reactions with Amines: RICHARD S. CURTISS and L. F. NICKELL.

In previous reports we have shown that the keto group of the oxomalonic esters, $O=C=(COOR)_2$, forms intermediate addition products with strongly basic substances as ammonia, and its substituted derivatives; with neutral compounds like the alcohols; and even with strongly negative molecules as the haloid acids. In continuation of this series of studies we have tried the action of hydrogen cyanide on ethyl oxomalonate.

The work was carried out at low temperatures with rigorous exclusion of moisture. The reaction proceeds with gradual loss in color of the green oxomalonate. The product is a colorless, unstable oil of the consistency of concentrated sulphuric acid. It slowly decomposes in the moisture of the air, giving off hydrogen cyanide.

This oil reacts vigorously with dry ammonia gas, giving a red resinous substance. The reaction carried out, however, with one molecule of the gas, in dry ether solution in a freezing mixture gives a white crystalline compound. Owing to its great instability this substance can hardly be kept long enough for an analysis.

The less volatile benzyl amine under similar conditions gives a white, crystalline compound of greater stability. The analysis corresponds to the following formula:

$$HO-C:(COOC_2H_5)_2$$

$$\begin{matrix}HN=C\\ HN=C\end{matrix}\Big\rangle N-CH_2-C_6H_5$$

$$HO - C : (COOC_2H_5)_2$$

A benzene solution of this product gives a white crystalline precipitate with dry hydrogen chloride, probably an amidine salt.

Dipropyl amine, on the other hand, adds to ethyl cyantartraonate in molecular proportions, giving likewise a white crystalline substance. It is less stable than the benzyl amine compound, and gives a similar crystalline product with dry hydrogen chloride. The analysis corresponds to the following formula:

$$\begin{array}{l} HO - C : (COOC_2H_5)_2 \\ \qquad\ \ | \\ HN = C - N : (C_3H_7)_2 \end{array}$$

The study of these and similar reactions is being continued.

Arsenic and Antimony Derivatives of Certain Organic Acids: J. Bishop Tingle and K. A. Clark.

The authors have prepared a number of new arsenic and antimony derivatives of succinic acid.

Similar experiments with camphoroxalic acid and with some of its more complex amino derivatives failed to give positive results.

Phthalphenylamidic acid (phthalanilic acid), under the conditions employed, was converted into the anil.

The experiments were made in an atmosphere of carbon dioxide, in order to avoid oxidation of the arsenious and antimonious oxides. Reference to this is made in another paper, which is presented before the inorganic section of this society.

Professor Abel has examined the therapeutic action of the new compounds mentioned above.

The Action of Halogen Acids upon Oxyxanthenols: M. Gomberg and C. J. West.

The Condensation of p-Dibrombenzene with Xanthone; a Contribution to the Knowledge of Quinocarbonium Salts: L. H. Cone and C. J. West.

The Action of Substituted Hydrazines on Beta-orthotoluquinone: William McPherson and Cecil Boord.

Beta-orthotoluquinone and its condensation products with unsymmetrical benzoylphenylhydrazine and unsymmetrical *p*-tolylhydrazine are described. The two latter products upon saponification yield benzeneazometacresol ($CH_3:OH:N_2 = 1:3:4$) and *p*-tolylazometacresol ($CH_3:OH:N_2 = 1:3:4$), respectively. A study of these derivatives is being made to determine the nature of orthohydroxyazo compounds.

The Derivatives of Choline: R. R. Renshaw.

Determination of Structure from Ionization: Clarence G. Derick.

Calculation of Ionization Constants from Structure: Clarence G. Derick.

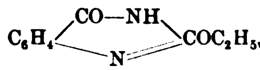
The "Beckman Rearrangement" of Triphenyl Methylhydroxylamine: J. Stieglitz and G. A. Reddick.

A Singular Case of Spontaneous Beckman Rearrangement: Lauder W. Jones.

Three Isomeric Ethyl Normal-propyl Hydroxylamines: Lauder W. Jones and Charles Hecker.

Oxygen Ethers of the Cyclic Ureas: Ralph H. McKee.

Finger and Zeh have described the compound formed by the action of methyl or ethyl anthranilate or cyanimido ethyl ether as *o*-carbethoxy phenylcyanamide. It is now shown that the substance actually formed is ethyl benzoylenisourea,



and not a substituted cyanamide at all. Incidentally carbethoxy and carbmethoxy phenylcyanamide were made by a method, which leaves no doubt as to their constitution, and found to possess the properties customarily observed in mono-substituted cyanamides and not at all those of the compound described by Finger and Zeh.

The Constitution of Dehydroacetic Acid: Wm. J. Hale.

The Composition of the Resene of Pinus heterophylla: Charles H. Herty.

The Action of Carbon Tetrabromide and Organic Bases: Wm. Dehn and A. H. Dewey.

The Action of Diiodo Acetylene upon Organic Bases: Wm. Dehn.

The Action of Tetraiodo Ethylene upon Organic Bases: Wm. Dehn.

The Action of Bromine on Certain Benzhydrols: Latham Clarke and G. J. Esselen, Jr.

The Action of Ethyl Magnesium Bromide on Anthraquinone: Latham Clarke and Paul W. Carleton.

2-2 Dimethyl-3 Methyl Pentane: Latham Clarke and W. N. Jones.

Carbohydrate Esters of the Higher Fatty Acids: Walter R. Bloor.

SCIENCE

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ADDRESS OF THE PRESIDENT OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

IT is now eighty years since this association first met at York, under the presidency of Earl Fitzwilliam. The object of the association was then explicitly stated: "To give a stronger impulse and a more systematic direction to scientific inquiry, to promote the intercourse of those who cultivate science in different parts of the British Empire with one another and with foreign philosophers, to obtain a more general attention to the objects of science and a removal of any disadvantages of a public kind which impede its progress."

In 1831 the workers in the domain of science were relatively few. The Royal Society, which was founded by Dr. Willis, Dr. Wilkins, and others, under the name of the "Invisible, or Philosophical College," about the year 1645, and which was incorporated in December, 1660, with the approval of King Charles II., was almost the only meeting-place for those interested in the progress of science; and its *Philosophical Transactions*, begun in March, 1664–5, almost the only medium of publication. Its character was described in the following words of a contemporary poem:

> "This noble learned Corporation
> Not for themselves are thus combined
> To prove all things by demonstration
> But for the public good of the nation
> And general benefit of mankind."

The first to hive off from the Royal Society was the Linnean Society for the promotion of botanical studies, founded in 1788 by Sir James Edward Smith, Sir

[1] Portsmouth, 1911.

Joseph Banks, and other Fellows of the Royal Society; in 1807 it was followed by the Geological Society; at a later date the Society of Antiquaries, the Chemical, the Zoological, the Physical, the Mathematical, and many other societies were founded. And it was felt by those capable of forming a judgment that, as well expressed by Lord Playfair at Aberdeen in 1885, "Human progress is so identified with scientific thought, both in its conception and realization, that it seems as if they were alternative terms in the history of civilization." This is only an echo through the ages of an utterance of the great Englishman, Roger Bacon, who wrote in 1250 A.D.: "Experimental science has three great prerogatives over all other sciences: it verifies conclusions by direct experiment; it discovers truths which they could never reach; and it investigates the secrets of Nature, and opens to us a knowledge of the past and of the future."

The world has greatly changed since 1831; the spread of railways and the equipment of numerous lines of steamships have contributed to the peopling of countries at that time practically uninhabited. Moreover, not merely has travelling been made almost infinitely easier, but communication by post has been enormously expedited and cheapened; and the telegraph, the telephone, and wireless telegraphy have simplified as well as complicated human existence. Furthermore, the art of engineering has made such strides that the question "Can it be done?" hardly arises, but rather "Will it pay to do it?" In a word, the human race has been familiarized with the applications of science; and men are ready to believe almost anything, if brought forward in its name.

Education, too, in the rudiments of science has been introduced into almost all schools; young children are taught the elements of physics and chemistry. The institution of a Section for Education in our Association (L) has had for its object the organizing of such instruction, and much useful advice has been proffered. The problem is, indeed, largely an educational one; it is being solved abroad in various ways—in Germany and in most European states by elaborate governmental schemes dealing with elementary and advanced instruction, literary, scientific, and technical; and in the United States and in Canada by the far-sightedness of the people: both employers and employees recognize the value of training and of originality, and on both sides sacrifices are made to ensure efficiency.

In England we have made technical education a local, not an imperial question; instead of half a dozen first-rate institutions of university rank, we have a hundred, in which the institutions are necessarily understaffed, in which the staffs are mostly overworked and underpaid; and the training given is that not for captains of industry, but for workmen and foremen. "Efficient captains cannot be replaced by a large number of fairly good corporals." Moreover, to induce scholars to enter these institutions, they are bribed by scholarships, a form of pauperization practically unknown in every country but our own; and to crown the edifice, we test results by examinations of a kind not adapted to gauge originality and character (if, indeed, these can ever be tested by examination), instead of, as on the Continent and in America, trusting the teachers to form an honest estimate of the capacity and ability of each student, and awarding honors accordingly.

The remedy lies in our own hands. Let me suggest that we exact from all gainers of university scholarships an undertaking that, if and when circumstances permit,

they will repay the sum which they have received as a scholarship, bursary, or fellowship. It would then be possible for an insurance company to advance a sum representing the capital value, *viz.*, 7,464,931*l.*, of the scholarships, reserving, say, twenty per cent. for non-payment, the result of mishap or death. In this way a sum of over six million pounds, of which the interest is now expended on scholarships, would be available for university purposes. This is about one-fourth of the sum of twenty-four millions stated by Sir Norman Lockyer at the Southport meeting as necessary to place our university education on a satisfactory basis. A large part of the income of this sum should be spent in increasing the emoluments of the chairs; for, unless the income of a professor is made in some degree commensurate with the earnings of a professional man who has succeeded in his profession, it is idle to suppose that the best brains will be attracted to the teaching profession. And it follows that unless the teachers occupy the first rank, the pupils will not be stimulated as they ought to be.

Again, having made the profession of a teacher so lucrative as to tempt the best intellects in the country to enter it, it is clear that such men are alone capable of testing their pupils. The modern system of "external examinations," known only in this country, and answerable for much of its lethargy, would disappear; schools of thought would arise in all subjects, and the intellectual as well as the industrial prosperity of our nation would be assured. As things are, can we wonder that as a nation we are not scientific? Let me recommend those of my hearers who are interested in the matter to read a recent report on Technical Education by the Science Guild.

I venture to think that, in spite of the remarkable progress of science and of its applications, there never was a time when missionary effort was more needed. Although most people have some knowledge of the results of scientific inquiry, few, very few, have entered into its spirit. We all live in hope that the world will grow better as the years roll on. Are we taking steps to secure the improvement of the race? I plead for recognition of the fact that progress in science does not only consist in accumulating information which may be put to practical use, but in developing a spirit of prevision, in taking thought for the morrow; in attempting to forecast the future, not by vague surmise, but by orderly marshalling of facts, and by deducing from them their logical outcome; and chiefly in endeavoring to control conditions which may be utilized for the lasting good of our people. We must cultivate a belief in the "application of trained intelligence to all forms of national activity."

The council of the association has had under consideration the formation of a section of agriculture. For some years this important branch of applied science, borrowing as it does from botany, from physics, from chemistry, and from economics, has in turn enjoyed the hospitality of each of these sections, itself having been made a subsection of one of these more definite sciences. It is proposed this year to form an agricultural section. Here, there is need of missionary effort; for our visits to our colonies have convinced many of us that much more is being done for the farmer in the newer parts of the British Empire than at home. Agriculture is, indeed, applied botany, chemistry, entomology, and economics; and has as much right to independent treatment as has engineering, which may be strictly regarded as applied physics.

The question has often been debated whether the present method of conducting

our proceedings is the one best adapted to gain our ends. We exist professedly "to give a stronger impulse and a more systematic direction to scientific inquiry." The council has had under consideration various plans framed with the object of facilitating our work, and the result of its deliberations will be brought under your attention at a later date. To my mind, the greatest benefit bestowed on science by our meetings is the opportunity which they offer for friendly and unrestrained intercourse, not merely between those following different branches of science, but also with persons who, though not following science professionally, are interested in its problems. Our meetings also afford an opportunity for younger men to make the acquaintance of older men. I am afraid that we who are no longer in the spring of our lifetime, perhaps from modesty, perhaps through carelessness, often do not sufficiently realize how stimulating to a young worker a little sympathy can be; a few words of encouragement go a long way. I have in my mind words which encouraged me as a young man, words spoken by the leaders of associations now long past—by Playfair, by Williamson, by Frankland, by Kelvin, by Stokes, by Francis Galton, by Fitzgerald and many others. Let me suggest to my older scientific colleagues that they should not let such pleasant opportunities slip.

Since our last meeting the Association has to mourn the loss by death of many distinguished members. Among these are:

Dr. John Beddoe, who served on the council from 1870 to 1875, has recently died at a ripe old age, after having achieved a world-wide reputation by his magnificent work in the domain of anthropology.

Sir Rubert Boyce, called away at a comparatively early age in the middle of his work, was for long a colleague of mine at University College, and was one of the staff of the Royal Commission on Sewage Disposal. The service he rendered science in combating tropical diseases is well known.

Sir Francis Galton died at the beginning of the year, at the advanced age of 89. His influence on science has been characterized by Professor Karl Pearson in his having maintained the idea that exact quantitative methods could—nay, must—be applied to many branches of science which had been held to be beyond the field of either mathematical or physical treatment. Sir Francis was general secretary of this association from 1863 to 1868; he was president of Section E in 1862, and again in 1872; he was president of Section H in 1885; but, although often asked to accept the office of president of the association, his consent could never be obtained. Galton's name will always be associated with that of his friend and relative, Charles Darwin, as one of the most eminent and influential of English men of science.

Professor Thomas Rupert Jones, also, like Galton, a member of this association since 1860, and in 1891 president of the Geological Section, died in April last at the advanced age of 91. Like Dr. Beddoe, he was a medical man with wide scientific interests. He became a distinguished geologist, and for many years edited the *Quarterly Journal* of the Geological Society.

Professor Story Maskelyne, at one time a diligent frequenter of our meetings, and a member of the council from 1874 to 1880, was a celebrated mineralogist and crystallographer. He died at the age of 88. The work which he did in the University of Oxford and at the British Museum is well known. In his later life he entered Parliament.

Dr. Johnstone Stoney, president of Section A in 1897, died on July 1, in his 86th year. He was one of the originators of the modern view of the nature of electricity,

having given the name "electron" to its unit as far back as 1874. His investigations dealt with spectroscopy and allied subjects, and his philosophic mind led him to publish a scheme of ontology which, I venture to think, must be acknowledged to be the most important work which has ever been done on that difficult subject.

Among our corresponding members we have lost Professor Bohr, of Copenhagen; Professor Brühl, of Heidelberg; Hofrat Dr. Caro, of Berlin; Professor Fittig, of Strassburg; and Professor Van't Hoff, of Berlin. I can not omit to mention that veteran of science, Professor Cannizzaro, of Rome, whose work in the middle of last century placed chemical science on the firm basis which it now occupies.

I knew all these men, some of them intimately; and, if I have not ventured on remarks as to their personal qualities, it is because it may be said of all of them that they fought a good fight and maintained the faith that only by patient and unceasing scientific work is human progress to be hoped for.

It has been the usual custom of my predecessors in office either to give a summary of the progress of science within the past year or to attempt to present in intelligible language some aspect of the science in which they have themselves been engaged. I possess no qualifications for the former course, and I therefore ask you to bear with me while I devote some minutes to the consideration of ancient and modern views regarding the chemical elements. To many in my audience part of my story will prove an oft-told tale; but I must ask those to excuse me, in order that it may be in some wise complete.

In the days of the early Greeks the word "element" was applied rather to denote a property of matter than one of its constituents. Thus, when a substance was said to contain fire, air, water, and earth (of which terms a childish game doubtless once played by all of us is a relic), it probably meant that they partook of the nature of the so-called elements. Inflammability showed the presence of concealed fire; the escape of "airs" when some substances are heated or when vegetable or animal matter is distilled no doubt led to the idea that these airs were imprisoned in the matters from which they escaped; hardness and permanence were ascribed to the presence of earth, while liquidity and fusibility were properties conveyed by the presence of concealed water. At a later date the "Spagyrics" added three "hypostatical principles" to the quadrilateral; these were "salt," "sulphur," and "mercury." The first conveyed solubility, and fixedness in fire; the second, inflammability; and the third, the power which some substances manifest of producing a liquid, generally termed "phlegm," on application of heat, or of themselves being converted into the liquid state by fusion.

It was Robert Boyle, in his "Skeptical Chymist," who first controverted these ancient and medieval notions, and who gave to the word "element" the meaning that it now possesses—the constituent of a compound. But in the middle of the seventeenth century chemistry had not advanced far enough to make his definition useful; for he was unable to suggest any particular substance as elementary. And, indeed, the main tenet of the doctrine of "phlogiston," promulgated by Stahl in the eighteenth century, and widely accepted, was that all bodies capable of burning or of being converted into a "calx," or earthy powder, did so in virtue of the escape of a subtle fluid from their pores; this fluid could be restored to the "calces" by heating them with other substances rich in phlogiston, such as charcoal, oil, flour and

the like. Stahl, however false his theory, had at least the merit of having constructed a reversible chemical equation: Metal — phlogiston = calx; calx + phlogiston = metal.

It is difficult to say when the first element was known to be an element. After Lavoisier's overthrow of the phlogistic hypothesis, the part played by oxygen, then recently discovered by Priestley and Scheele, came prominently forward. Loss of phlogiston was identified with oxidation; gain of phlogiston, with loss of oxygen. The scheme of nomenclature ("Méthode de Nomenclature chimique"), published by Lavoisier in conjunction with Guyton de Morveau, Berthollet and Fourcroy, created a system of chemistry out of a wilderness of isolated facts and descriptions. Shortly after, in 1789, Lavoisier published his "Traité de Chimie," and in the preface the words occur: "If we mean by 'elements' the simple and indivisible molecules of which bodies consist, it is probable that we do not know them; if, on the other hand, we mean the last term in analysis, then every substance which we have not been able to decompose is for us an element; not that we can be certain that bodies which we regard as simple are not themselves composed of two or even a larger number of elements, but because these elements can never be separated, or rather, because we have no means of separating them, they act, so far as we can judge, as elements; and we can not call them 'simple' until experiment and observation shall have furnished a proof that they are so."

The close connection between "crocus of Mars" and metallic iron, the former named by Lavoisier "oxyde de fer," and similar relations between metals and their oxides, made it likely that bodies which reacted as oxides in dissolving in acids and forming salts must also possess a metallic substratum. In October, 1807, Sir Humphry Davy proved the correctness of this view for soda and potash by his famous experiment of splitting these bodies by a powerful electric current into oxygen and hydrogen on the one hand, and the metals sodium and potassium on the other. Calcium, barium, strontium and magnesium were added to the list as constituents of the oxides, lime, barytes, strontia, and magnesia. Some years later Scheele's "dephlogisticated marine acid," obtained by heating pyrolusite with "spirit of salt," was identified by Davy as in all likelihood elementary. His words are: "All the conclusions which I have ventured to make respecting the undecompounded nature of oxymuriatic gas are, I conceive, entirely confirmed by these new facts." "It has been judged most proper to suggest a name founded upon one of its obvious and characteristic properties, its color, and to call it chlorine." The subsequent discovery of iodine by Courtois in 1812, and of bromine by Balard in 1826, led to the inevitable conclusion that fluorine, if isolated, should resemble the other halogens in properties, and much later, in the able hands of Moissan, this was shown to be true.

The modern conception of the elements was much strengthened by Dalton's revival of the Greek hypothesis of the atomic constitution of matter, and the assigning to each atom a definite weight. This momentous step for the progress of chemistry was taken in 1803; the first account of the theory was given to the public with Dalton's consent in the third edition of Thomas Thomson's "System of Chemistry" in 1807; it was subsequently elaborated in the first volume of Dalton's own "System of Chemical Philosophy," published in 1808. The notion that compounds consisted of aggregations of atoms of elements, united

in definite or multiple proportions, familiarized the world with the conception of elements as the bricks of which the universe is built. Yet the more daring spirits of that day were not without hope that the elements themselves might prove decomposable. Davy, indeed, went so far as to write in 1811: "It is the duty of the chemist to be bold in pursuit; he must recollect how contrary knowledge is to what appears to be experience. . . . To enquire whether the elements be capable of being composed and decomposed is a grand object of true philosophy." And Faraday, his great pupil and successor, at a later date, 1815, was not behind Davy in his aspirations, when he wrote: "To decompose the metals, to re-form them, and to realize the once absurd notion of transformation—these are the problems now given to the chemist for solution."

Indeed, the ancient idea of the unitary nature of matter was in those days held to be highly probable. For attempts were soon made to demonstrate that the atomic weights were themselves multiples of that of one of the elements. At first the suggestion was that oxygen was the common basis; and later, when this supposition turned out to be untenable, the claims of hydrogen were brought forward by Prout. The hypothesis was revived in 1842 when Liebig and Redtenbacher, and subsequently Dumas, carried out a revision of the atomic weights of some of the commoner elements, and showed that Berzelius was in error in attributing to carbon the atomic weight 12.25, instead of 12.00. Of recent years a great advance in the accuracy of the determinations of atomic weights has been made, chiefly owing to the work of Richards and his pupils, of Gray, and of Guye and his collaborators, and every year an international committee publishes a table in which the most probable numbers are given on the basis of the atomic weight of oxygen being taken as sixteen. In the table for 1911, of eighty-one elements no fewer than forty-three have recorded atomic weights within one-tenth of a unit above or below an integral number. My mathematical colleague, Karl Pearson, assures me that the probability against such a condition being fortuitous is 20,000 millions to one.

The relation between the elements has, however, been approached from another point of view. After preliminary suggestions by Döbereiner, Dumas and others, John Newlands in 1862 and the following years arranged the elements in the numerical order of their atomic weights, and published in the *Chemical News* of 1863 what he termed his law of octaves—that every eighth element, like the octave of a musical note, is in some measure a repetition of its forerunner. Thus, just as C on the third space is the octave of C below the line, so potassium, in 1863 the eighth known element numerically above sodium, repeats the characters of sodium, not only in its physical properties—color, softness, ductility, malleability, etc.—but also in the properties of its compounds, which, indeed, resemble each other very closely. The same fundamental notion was reproduced at a later date and independently by Lothar Meyer and Dmitri Mendeléeff; and to accentuate the recurrence of such similar elements in *periods*, the expression "the periodic system of arranging the elements" was applied to Newlands's arrangement in octaves. As everyone knows, by help of this arrangement Mendeléeff predicted the existence of then unknown elements, under the names of eka-boron, eka-aluminium and eka-silicon, since named *scandium*, *gallium* and *germanium*, by their discoverers, Cleve, Lecoq de Boisbaudran, and Winckler.

It might have been supposed that our knowledge of the elements was practically

complete; that perhaps a few more might be discovered to fill the outstanding gaps in the periodic table. True, a puzzle existed and still exists in the classification of the "rare earths," oxides of metals occurring in certain minerals; these metals have atomic weights between 139 and 180, and their properties preclude their arrangement in the columns of the periodic table. Besides these, the discovery of the inert gases of the atmosphere, of the existence of which Johnstone Stoney's spiral curve, published in 1888, pointed a forecast, joined the elements like sodium and potassium, strongly electro-negative, to those like fluorine and chlorine, highly electro-positive, by a series of bodies electrically as well as chemically inert, and neon, argon, krypton, and xenon formed links between fluorine and sodium, chlorine and potassium, bromine and rubidium, and iodine and cæsium.

Including the inactive gases, and adding the more recently discovered elements of the rare earths, and radium, of which I shall have more to say presently, there are eighty-four definite elements, all of which find places in the periodic table, if merely numerical values be considered. Between lanthanum, with atomic weight 139, and tantalum, 181, there are in the periodic table seventeen spaces; and although it is impossible to admit, on account of their properties, that the elements of the rare earths can be distributed in successive columns (for they all resemble lanthanum in properties), yet there are now fourteen such elements; and it is not improbable that other three will be separated from the complex mixture of their oxides by further work. Assuming that the metals of the rare earths fill these seventeen spaces, how many still remain to be filled? We will take for granted that the atomic weight of uranium, 238.5, which is the highest known, forms an upper limit not likely to be surpassed. It is easy to count the gaps; there are eleven.

But we are confronted by an *embarras de richesse*. The discovery of radioactivity by Henri Becquerel, of radium by the Curies, and the theory of the disintegration of the radioactive elements, which we owe to Rutherford and Soddy, have indicated the existence of no fewer than twenty-six elements hitherto unknown. To what places in the periodic table can they be assigned?

But what proof have we that these substances are elementary? Let us take them in order.

Beginning with radium, its salts were first studied by Madame Curie; they closely resemble those of barium—sulphate, carbonate, and chromate insoluble; chloride and bromide similar in crystalline form to chloride and bromide of barium; metal, recently prepared by Madame Curie, white, attacked by water, and evidently of the type of barium. The atomic weight, too, falls into its place; as determined by Madame Curie and by Thorpe, it is 89.5 units higher than that of barium; in short, there can be no doubt that radium fits the periodic table, with an atomic weight of about 226.5. It is an undoubted element.

But it is a very curious one. For it is *unstable*. Now, stability was believed to be the essential characteristic of an element. Radium, however, disintegrates—that is, changes into other bodies, and at a constant rate. If 1 gram of radium is kept for 1,760 years, only half a gram will be left at the end of that time; half of it will have given other products. What are they? We can answer that question. Rutherford and Soddy found that it gives a condensable gas, which they named "radium-emanation"; and Soddy and I, in 1903, discovered that, in addition, it evolves helium,

one of the inactive series of gases, like argon. Helium is an undoubted element, with a well-defined spectrum; it belongs to a well-defined series. And radium-emanation, which was shown by Rutherford and Soddy to be incapable of chemical union, has been liquefied and solidified in the laboratory of University College, London, its spectrum has been measured and its density determined. From the density the atomic weight can be calculated, and it corresponds with that of a congener of argon, the whole series being: helium, 4; neon, 20; argon, 40; krypton, 83; xenon, 130; unknown, about 178; and niton (the name proposed for the emanation to recall its connection with its congeners, and its phosphorescent properties), about 222.4. The formation of niton from radium would therefore be represented by the equation: radium (226.4) = helium (4) + niton (222.4).

Niton, in its turn, disintegrates, or decomposes, and at a rate much more rapid than the rate of radium; half of it has changed in about four days. Its investigation, therefore, had to be carried out very rapidly, in order that its decomposition might not be appreciable while its properties were being determined. Its product of change was named by Rutherford "radium A," and it is undoubtedly deposited from niton as a metal, with simultaneous evolution of helium; the equation would therefore be: niton (222.4) = helium (4) + radium A (218.4). But it is impossible to investigate radium A chemically, for in three minutes it has half changed into another solid substance, radium B, again giving off helium. This change would be represented by the equation: radium A (218.4) = helium (4) + radium B (214.4). Radium B, again, can hardly be examined chemically, for in twenty-seven minutes it has half changed into radium C^1. In this case, however, no helium is evolved; only atoms of negative electricity, to which the name "electrons" has been given by Dr. Stoney, and these have minute weight which, although approximately ascertainable, at present has defied direct measurement. Radium C^1 has a half-life of 19.5 minutes; too short, again, for chemical investigation; but it changes into radium C^2, and in doing so, each atom parts with a helium atom; hence the equation: —radium C^1 (214.4) = helium (4) + radium C^2 (210.4). In 2.5 minutes, radium C^2 is half gone, parting with electrons, forming radium D. Radium D gives the chemist a chance, for its half-life is no less than sixteen and a half years. Without parting with anything detectable, radium D passes into radium E, of which the half-life period is five days; and lastly radium E changes spontaneously into radium F, the substance to which Madame Curie gave the name "polonium" in allusion to her native country, Poland. Polonium, in its turn, is half changed in 140 days with loss of an atom of helium into an unknown metal, supposed to be possibly lead. If that be the case, the equation would run: polonium (210.4) = helium (4) + lead (206.4). But the atomic weight of lead is 207.1, and not 206.4; however, it is possible that the atomic weight of radium is 227.1, and not 226.4.

We have another method of approaching the same subject. It is practically certain that the progenitor of radium is uranium; and that the transformation of uranium into radium involves the loss of three alpha particles; that is, of three atoms of helium. The atomic weight of helium may be taken as one of the most certain; it is 3.994, as determined by Mr. Watson, in my laboratories. Three atoms would therefore weigh 11.98, practically 12. There is, however, still some uncertainty in the atomic weight of uranium; Richards and Merigold make

it 239.4; but the general mean, calculated by Clarke, is 239.0. Subtracting 12 from these numbers, we have the values 227.0, and 227.4 for the atomic weight of radium. It is as yet impossible to draw any certain conclusion.

The importance of the work which will enable a definite and sure conclusion to be drawn is this: For the first time, we have accurate knowledge as to the descent of some of the elements. Supposing the atomic weight of uranium to be certainly 239, it may be taken as proved that in losing three atoms of helium, radium is produced, and, if the change consists solely in the loss of the three atoms of helium, the atomic weight of radium must necessarily be 227. But it is known that β-rays, or electrons, are also parted with during this change; and electrons have weight. How many electrons are lost is unknown; therefore, although the weight of an electron is approximately known, it is impossible to say how much to allow for in estimating the atomic weight of radium. But it is possible to solve this question indirectly, by determining exactly the atomic weights of radium and of uranium; the difference between the atomic weight of radium *plus* 12, *i. e.*, plus the weight of three atoms of helium, and that of uranium, will give the weight of the number of electrons which escape. Taking the most probable numbers available, viz., 239.4 for uranium and 226.8 for radium, and adding 12 to the latter, the weight of the escaping electrons would be 0.6.

The correct solution of this problem would in great measure clear up the mystery of the irregularities in the periodic table, and would account for the deviations from Prout's law, that the atomic weights are multiples of some common factor or factors. I also venture to suggest that it would throw light on allotropy, which in some cases at least may very well be due to the loss or gain of electrons, accompanied by a positive or negative heat-change. Incidentally, this suggestion would afford places in the periodic table for the somewhat overwhelming number of pseudo-elements the existence of which is made practically certain by the disintegration hypothesis. Of the twenty-six elements derived from uranium, thorium, and actinium, ten, which are formed by the emission of electrons alone, may be regarded as allotropes or pseudo-elements; this leaves sixteen, for which sixteen or seventeen gaps would appear to be available in the periodic table, provided the reasonable supposition be made that a second change in the length of the periods has taken place. It is above all things certain that it would be a fatal mistake to regard the existence of such elements as irreconcilable with the periodic arrangement, which has rendered to systematic chemistry such signal service in the past.

Attention has repeatedly been drawn to the enormous quantity of energy stored up in radium and its descendants. That in its emanation niton is such that if what it parts with as heat during its disintegration were available, it would be equal to three and a half million times the energy available by the explosion of an equal volume of detonating gas—a mixture of one volume of oxygen with two volumes of hydrogen. The major part of this energy comes, apparently, from the expulsion of particles (that is, of atoms of helium) with enormous velocity. It is easy to convey an idea of this magnitude in a form more realizable, by giving it a somewhat mechanical turn. Suppose that the energy in a ton of radium could be utilized in thirty years, instead of being evolved at its invariable slow rate of 1,760 years for half-disintegration, it would suffice to propel a ship

of 15,000 tons, with engines of 15,000 horse-power, at the rate of 15 knots an hour, for 30 years—practically the lifetime of the ship. To do this actually requires a million and a half tons of coal.

It is easily seen that the virtue of the energy of the radium consists in the small weight in which it is contained; in other words, the radium-energy is in an enormously concentrated form. I have attempted to apply the energy contained in niton to various purposes; it decomposes water, ammonia, hydrogen chloride and carbon dioxide, each into its constituents; further experiments on its action on salts of copper appeared to show that the metal copper was converted partially into lithium, a metal of the sodium column; and similar experiments, of which there is not time to speak, indicate that thorium, zirconium, titanium and silicon are degraded into carbon; for solutions of compounds of these, mixed with niton, invariably generated carbon dioxide; while cerium, silver, mercury and some other metals gave none. One can imagine the very atoms themselves, exposed to bombardment by enormously quickly moving helium atoms failing to withstand the impacts. Indeed, the argument *a priori* is a strong one; if we know for certain that radium and its descendants decompose spontaneously, evolving energy, why should not other more stable elements decompose when subjected to enormous strains?

This leads to the speculation whether, if elements are capable of disintegration, the world may not have at its disposal a hitherto unsuspected source of energy. If radium were to evolve its stored-up energy at the same rate that gun-cotton does, we should have an undreamt-of explosive; could we control the rate we should have a useful and potent source of energy, provided always that a sufficient supply of radium were forthcoming. But the supply is certainly a very limited one; and it can be safely affirmed that the production will never surpass half an ounce a year. If, however, the elements which we have been used to consider as permanent are capable of changing with evolution of energy; if some form of catalyzer could be discovered which would usefully increase their almost inconceivably slow rate of change, then it is not too much to say that the whole future of our race would be altered.

The whole progress of the human race has indeed been due to individual members discovering means of concentrating energy, and of transforming one form into another. The carnivorous animals strike with their paws and crush with their teeth; the first man who aided his arm with a stick in striking a blow discovered how to concentrate his small supply of kinetic energy; the first man who used a spear found that its sharp point in motion represented a still more concentrated form; the arrow was a further advance, for the spear was then propelled by mechanical means; the bolt of the crossbow, the bullet shot forth by compressed hot gas, first derived from black powder, later, from high explosives; all these represent progress. To take another sequence: the preparation of oxygen by Priestley applied energy to oxide of mercury in the form of heat; Davy improved on this when he concentrated electrical energy into the tip of a thin wire by aid of a powerful battery, and isolated potassium and sodium.

Great progress has been made during the past century in effecting the conversion of one form of energy into others, with as little useless expenditure as possible. Let me illustrate by examples: A good steam engine converts about one eighth of the potential energy of the fuel into useful work; seven eighths are lost as unused heat

and useless friction. A good gas-engine utilizes more than one third of the total energy in the gaseous fuel; two thirds are uneconomically expended. This is a universal proposition; in order to effect the conversion from one form of energy into another, some energy must be expended uneconomically. If A is the total energy which it is required to convert; if B is the energy into which it is desired to convert A; then a certain amount of energy, C, must be expended to effect the conversion. In short, $A = B + C$. It is eminently desirable to keep C, the useless expenditure, as small as possible; it can never equal zero, but it can be made small. The ratio of C to B (the economic coefficient) should therefore be as large as is attainable.

The middle of the nineteenth century will always be noted as the beginning of the golden age of science; the epoch when great generalizations were made, of the highest importance on all sides, philosophical, economic and scientific. Carnot, Clausius, Helmholtz, Julius Robert Mayer abroad, and the Thomsons, Lord Kelvin and his brother James, Rankine, Tait, Joule, Clerk Maxwell and many others at home, laid the foundations on which the splendid structure has been erected. That the latent energy of fuel can be converted into energy of motion by means of the steam engine is what we owe to Newcomen and Watt; that the kinetic energy of the fly-wheel can be transformed into electrical energy was due to Faraday, and to him, too, we are indebted for the reconversion of electrical energy into mechanical work; and it is this power of work which gives us leisure, and which enables a small country like ours to support the population which inhabits it.

I suppose that it will be generally granted that the commonwealth of Athens attained a high-water mark in literature and thought, which has never yet been surpassed. The reason is not difficult to find; a large proportion of its people had ample leisure, due to ample means; they had time to think and time to discuss what they thought. How was this achieved? The answer is simple: each Greek freeman had on an average at least five helots who did his bidding, who worked his mines, looked after his farm, and, in short, saved him from manual labor. Now, we in Britain are much better off; the population of the British Isles is in round numbers 45 millions; there are consumed in our factories at least 50 million tons of coal annually, and "it is generally agreed that the consumption of coal per indicated horse-power per hour is on an average about 5 lb." (Royal Commission on Coal Supplies, Part I.) This gives seven million horse-power per year. How many man-power are equal to a horse-power? I have arrived at an estimate thus: A Bhutanese can carry 230 lb. *plus* his own weight, in all 400 lb., up a hill 4,000 feet high in eight hours; this is equivalent to about one twenty-fifth of a horse-power; seven million horse-power are therefore about 175 million man-power. Taking a family as consisting on the average of five persons, our 45 millions would represent nine million families; and dividing the total man-power by the number of families, we must conclude that each British family has, on the average, nearly twenty "helots" doing his bidding, instead of the five of the Athenian family. We do not appear, however, to have gained more leisure thereby, but it is this that makes it possible for the British Isles to support the population which it does.

We have in this world of ours only a limited supply of stored-up energy; in the British Isles a very limited one—namely, our coalfields. The rate at which this sup-

ply is being exhausted has been increasing very steadily for the last forty years, as any one can prove by mapping the data given on page 27, table D, of the General Report of the Royal Commission on Coal Supplies (1906). In 1870 110 million tons were mined in Great Britain, and ever since the amount has increased by three and a third million tons a year. The available quantity of coal in the proved coalfields is very nearly 100,000 million tons; it is easy to calculate that if the rate of working increases as it is doing our coal will be completely exhausted in 175 years. But, it will be replied, the rate of increase will slow down. Why? It has shown no sign whatever of slackening during the last forty years. Later, of course, it must slow down, when coal grows dearer owing to approaching exhaustion. It may also be said that 175 years is a long time; why, I myself have seen a man whose father fought in the '45 on the Pretender's side, nearly 170 years ago! In the life of a nation 175 years is a span.

This consumption is still proceeding at an accelerated rate. Between 1905 and 1907 the amount of coal raised in the United Kingdom increased from 236 to 268 million tons, equal to six tons per head of the population, against three and a half tons in Belgium, two and a half tons in Germany and one ton in France. Our commercial supremacy and our power of competing with other European nations are obviously governed, so far as we can see, by the relative price of coal; and when our prices rise, owing to the approaching exhaustion of our supplies, we may look forward to the near approach of famine and misery.

Having been struck some years ago with the optimism of my non-scientific friends as regards our future, I suggested that a committee of the British Science Guild should be formed to investigate our available sources of energy. This guild is an organization, founded by Sir Norman Lockyer, after his tenure of the presidency of this association, for the purpose of endeavoring to impress on our people and their government the necessity of viewing problems affecting the race and the state from the standpoint of science; and the definition of science in this, as in other connections, is simply the acquisition of knowledge, and orderly reasoning on experience already gained and on experiments capable of being carried out, so as to forecast and control the course of events; and, if possible, to apply this knowledge to the benefit of the human race.

The Science Guild has enlisted the services of a number of men, each eminent in his own department, and each has now reported on the particular source of energy of which he has special knowledge.

Besides considering the uses of coal and its products, and how they may be more economically employed, in which branches the Hon. Sir Charles Parsons, Mr. Dugald Clerk, Sir Boverton Redwood, Dr. Beilby, Dr. Hele-Shaw, Professor Vivian Lewes and others have furnished reports, the following sources of energy have been brought under review: The possibility of utilizing the tides; the internal heat of the earth; the winds; solar heat; water-power; the extension of forests, and the use of wood and peat as fuels; and lastly, the possibility of controlling the undoubted but almost infinitely slow disintegration of the elements, with the view of utilizing their stored-up energy.

However interesting a detailed discussion of these possible sources of energy might be, time prevents my dwelling on them. Suffice it to say that the Hon. R. J. Strutt has shown that in this country at least it would be impracticable to attempt

to utilize terrestrial heat from boreholes; others have deduced that from the tides, the winds and water-power small supplies of energy are no doubt obtainable, but that, in comparison with that derived from the combustion of coal, they are negligible; nothing is to be hoped for from the direct utilization of solar heat in this temperate and uncertain climate; and it would be folly to consider seriously a possible supply of energy in a conceivable acceleration of the liberation of energy by atomic change. It looks utterly improbable, too, that we shall ever be able to utilize the energy due to the revolution of the earth on her axis, or to her proper motion round the sun.

Attention should undoubtedly be paid to forestry, and to the utilization of our stores of peat. On the continent, the forests are largely the property of the state; it is unreasonable, especially in these latter days of uncertain tenure of property, to expect any private owner of land to invest money in schemes which would at best only benefit his descendants, but which, under our present trend of legislation, do not promise even that remote return. Our neighbors and rivals, Germany and France, spend annually 2,200,000*l*. on the conservation and utilization of their forests; the net return is 6,000,000*l*. There is no doubt that we could imitate them with advantage. Moreover, an increase in our forests would bring with it an increase in our water-power; for without forest land rain rapidly reaches the sea, instead of distributing itself, so as to keep the supply of water regular, and so more easily utilized.

Various schemes have been proposed for utilizing our deposits of peat: I believe that in Germany the peat industry is moderately profitable; but our humid climate does not lend itself to natural evaporation of most of the large amount of water contained in peat, without which processes of distillation prove barely remunerative.

We must therefore rely chiefly on our coal reserve for our supply of energy, and for the means of supporting our population; and it is to the more economical use of coal that we must look, in order that our life as a nation may be prolonged. We can economize in many ways: By the substitution of turbine engines for reciprocating engines, thereby reducing the coal required per horse-power from 4 to 5 lb. to 1½ or 2 lb.; by the further replacement of turbines by gas engines, raising the economy to 30 per cent. of the total energy available in the coal, that is, lowering the coal consumption per horse-power to 1 or 1¼ lb.; by creating the power at the pit-mouth, and distributing it electrically, as is already done in the Tyne district. Economy can also be effected in replacing "bee-hive" coke ovens by recovery ovens; this is rapidly being done; and Dr. Beilby calculates that in 1909 nearly six million tons of coal, out of a total of sixteen to eighteen millions, were coked in recovery ovens, thus effecting a saving of two to three million tons of fuel annually. Progress is also being made in substituting gas for coal or coke in metallurgical, chemical and other works. But it must be remembered that for economic use, gaseous fuel must not be charged with the heavy costs of piping and distribution.

The domestic fire problem is also one which claims our instant attention. It is best grappled with from the point of view of smoke. Although the actual loss of thermal energy in the form of smoke is small—at most less than a half per cent. of the fuel consumed—still the presence of smoke is a sign of waste of fuel and careless stoking. In works, mechanical stokers which ensure regularity of firing and complete combustion of fuel are more and more widely replacing hand-firing. But we are still utterly wasteful in our consumption of fuel in domestic fires. There is prob-

ably no single remedy applicable; but the introduction of central heating, of gas fires and of grates which permit of better utilization of fuel will all play a part in economizing our coal. It is open to argument whether it might not be wise to hasten the time when smoke is no more by imposing a sixpenny fine for each offence; an instantaneous photograph could easily prove the offense to have been committed; and the imposition of the fine might be delayed until three warnings had been given by the police.

Now I think that what I wish to convey will be best expressed by an allegory. A man of mature years who has surmounted the troubles of childhood and adolescence without much disturbance to his physical and mental state, gradually becomes aware that he is suffering from loss of blood; his system is being drained of this essential to life and strength. What does he do? If he is sensible, he calls in a doctor, or perhaps several, in consultation; they ascertain the seat of the disease, and diagnose the cause. They point out that while consumption of blood is necessary for healthy life, it will lead to a premature end if the constantly increasing drain is not stopped. They suggest certain precautionary measures; and if he adopts them, he has a good chance of living at least as long as his contemporaries; if he neglects them, his days are numbered.

That is our condition as a nation. We have had our consultation in 1903; the doctors were the members of the Coal Commission. They showed the gravity of our case, but we have turned a deaf ear.

It is true that the self-interest of coal consumers is slowly leading them to adopt more economical means of turning coal into energy. But I have noticed and frequently publicly announced a fact which cannot but strike even the most unobservant. It is this: When trade is good, as it appears to be at present, manufacturers are making money; they are overwhelmed with orders, and have no inclination to adopt economies which do not appear to them to be essential, and the introduction of which would take thought and time, and which would withdraw the attention of their employees from the chief object of the business—how to make the most of the present opportunities. Hence improvements are postponed. When bad times come, then there is no money to spend on improvements; they are again postponed until better times arive.

What can be done?

I would answer: Do as other nations have done and are doing; take stock annually. The Americans have a permanent commission initiated by Mr. Roosevelt, consisting of three representatives from each state, the sole object of which is to keep abreast with the diminution of the stores of natural energy, and to take steps to lessen its rate. This is a non-political undertaking, and one worthy of being initiated by the ruler of a great country. If the example is followed here the question will become a national one.

Two courses are open to us; first, the *laissez-faire* plan of leaving to self-interested competition the combating of waste; or second, initiating legislation which, in the interest of the whole nation, will endeavor to lessen the squandering of our national resources. This legislation may be of two kinds: penal, that is, imposing a penalty on wasteful expenditure of energy-supplies; and helpful, that is, imparting information as to what can be done, advancing loans at an easy rate of interest to enable reforms to be carried out, and insisting on the greater prosperity which would result from the use of more efficient appliances.

This is not the place, nor is there the time, to enter into detail; the subject is a

complicated one, and it will demand the combined efforts of experts and legislators for a generation; but if it be not considered with the definite intention of immediate action, we shall be held up to the deserved execration of our not very remote descendants.

The two great principles which I have alluded to in an earlier part of this address must not, however, be lost sight of; they should guide all our efforts to use energy economically. Concentration of energy in the form of electric current at high potential makes it possible to convey it for long distances through thin and therefore comparatively inexpensive wires; and the economic coefficient of the conversion of mechanical into electrical, and of electrical into mechanical energy is a high one; the useless expenditure does not much exceed one twentieth part of the energy which can be utilized. These considerations would point to the conversion at the pit-mouth of the energy of the fuel into electrical energy, using as an intermediary, turbines, or preferably gas engines; and distributing the electrical energy to where it is wanted. The use of gas engines may, if desired, be accompanied by the production of half-distilled coal, a fuel which burns nearly without smoke, and one which is suitable for domestic fires, if it is found too difficult to displace them and to induce our population to adopt the more efficient and economical systems of domestic heating which are used in America and on the continent. The increasing use of gas for factory, metallurgical and chemical purposes points to the gradual concentration of works near the coal mines, in order that the laying-down of expensive piping may be avoided.

An invention which would enable us to convert the energy of coal directly into electrical energy would revolutionize our ideas and methods, yet it is not unthinkable. The nearest practical approach to this is the Mond gas-battery, which, however, has not succeeded, owing to the imperfection of the machine.

In conclusion, I would put in a plea for the study of pure science, without regard to its applications. The discovery of radium and similar radioactive substances has widened the bounds of thought. While themselves, in all probability, incapable of industrial application, save in the domain of medicine, their study has shown us to what enormous advances in the concentration of energy it is permissible to look forward, with the hope of applying the knowledge thereby gained to the betterment of the whole human race. As charity begins at home, however, and as I am speaking to the *British* Association for the Advancement of Science, I would urge that our first duty is to strive for all which makes for the permanence of the British commonweal, and which will enable us to transmit to our posterity a heritage not unworthy to be added to that which we have received from those who have gone before.

William Ramsay

THE FIRST UNIVERSAL RACES CONGRESS

Thanks to the indefatigable energy and enthusiasm of Mr. Gustav Spiller, who was ably assisted by Mrs. Spiller and supported by a large and representative committee, a new departure in the history of the world has been made by bringing together representatives of many classes of varied peoples to confer on the problems connected with the contact of races and peoples. During the week of the congress there could be seen in the halls of the University of London men and women of all shades of color and of different religions in friendly converse or planning schemes for breaking down racial and other prejudice, as well as for the betterment of mankind. For the majority it was a very serious occasion, as it is evident that they would not have come from such great distances at considerable expense and trouble if they had not thought it

worth while. From this point of view the sight was pathetic as well as inspiriting. It is too early to form an opinion as to what the permanent result will be; at all events, many grievances have been laid bare, and those who were not too engrossed with their particular troubles or obsessed with their pet panacea will realize that there are very many difficult problems to face, the solution of which can only be made by calm thinking and long, patient work. Sentiment and rhetoric may initiate reforms, but their realization is mainly due to what may be termed mechanical methods.

A permanent result of the congress is to be found in the volume entitled "Inter-racial Problems" (Boston, The World's Peace Foundation, 29 A. Beacon St.), which contains some sixty articles specially written for the congress by more or less well-known people of diverse nationality. The authors had time to consider what they had to write and thus were able to give data and reasoned argument, as well as, in some cases, to formulate a constructive policy. The essays are naturally of unequal merit, but collectively they constitute an informing book on many social problems. Some of the speeches were also logical, sane and constructive, but their effect must necessarily be more transient, and the sultry weather combined with the poor acoustic properties of the hall further minimized their importance. No discussion was possible under the circumstances, each speaker was necessarily limited as to time, and many attempted to obviate this restriction by rapid utterance which really defeated their object. Even those who might have been expected to give data or argument may have felt that the conditions were unfavorable and so adopted a more rhetorical method. What has become of all the ideas that were promulgated? Unless there was an official stenographer the vast majority of them must have perished. No human being, even if he caught all that was said or understood the various languages that were spoken, could carry away more than a fraction of what he heard. A considerable number of patient souls seem to have sat through everything; if they appreciated all that transpired their minds must have become very confused and their feelings painfully lacerated.

Without the least intention of being uncharitable, it appeared that a certain class wished to believe more than facts warrant. For example, because the anthropologists admitted that there was probably no race which would be described as pure, therefore races were chimerical; because skin-color is not of primary value in classifying peoples, the official program speaks of "so-called white and so-called colored peoples"; because the environment produces changes in certain physical characters (but to what extent, in what time, or how permanent they may be in modern times, we have practically no information) the classification of human varieties is a vain task. One anthropologist "swam against the current to the congress" by asserting that "the brotherhood of man is a good thing, but the struggle for life is a far better one." Another said he did not agree that all races were equal or that the differences were due solely to environment. It was not for the good of the world that all races should be equal, nor would they ever be, but it was desirable that all should have an equal chance of development. A third hoped that the ideas and ideals of various peoples would remain distinct and not merged into a common type of humanity. All agreed that there should be a sympathy based on mutual knowledge and forbearance among different nationalities. Taken from one point of view, much that was said by the anthropologists might be construed as supporting the views of a large number of the members of the congress, but the latter seem to have overlooked the very important element of time. Dr. C. S. Myres in his printed paper says: "If we assume, as I think we must assume, that the white and negro races owe their respective characters ultimately to their environment, there is no *a priori* reason, it seems to me. for denying the possibility of a reversal of their [mental and physical] differences, if the environment to which they are respectively exposed be

gradually, in the course of many hundreds of thousands of years, reversed." In some speeches often unmerited blame was bestowed on systems of government or on government officials without a due consideration of the special circumstances or the difficulties of the situation. What so many ardent spirits can not appreciate is that safe progress is slow progress and that compromises have to be made. Another fallacy was manifest in the belief that one system of government is suitable for all types of humanity. But most of the obvious defects were just those which were practically inevitable; the delegates and others were mainly those who came in response to strong emotion, and desired to draw attention to their own or their friends' grievances.

The social atmosphere was highly charged. They wanted things said in the hope of getting things done. Each fanned the flame of his own enthusiasm and that of others. There is no doubt that the congress has resulted in much friendliness between members of different nations, perhaps some misunderstandings have been removed, conscience has been stimulated, but the prosaic work remains to be done.

A. C. Haddon

THE MARINE BIOLOGICAL LABORATORY

The investigators working at the Marine Biological Laboratory at Woods Hole, during a part or the whole of the season, have been as follows:

Abbott, James Francis, professor of zoology, Washington University, St. Louis.

Abbott, Margaret B., Bennett School, Millbrook, New York.

Addison, W. H. F., demonstrator of histology and embryology, University of Pennsylvania.

Allyn, Harriet M., fellow in zoology, University of Chicago.

Amberg, Samuel, associate professor of pediatrics, Johns Hopkins University.

Bancroft, Frank W., associate, Rockefeller Institute for Medical Research, New York City.

Bartelmez, George W., associate in anatomy, University of Chicago.

Beckwith, Cora J., instructor in biology, Vassar College.

Beutner, Reinhard, assistant, Rockefeller Institute for Medical Research.

Bradley, H. C., assistant professor of physiological chemistry, University of Wisconsin.

Browne, Ethel N., graduate student, Columbia University.

Budington, Robert A., associate professor of zoology, Oberlin College.

Calkins, Gary N., professor of protozoology, Columbia University.

Chambers, Robert, lecturer and laboratory assistant in zoology, University of Toronto.

Clapp, Cornelia M., professor of zoology, Mount Holyoke College.

Conklin, E. G., professor of zoology, Princeton University.

Craig, Wallace, professor of philosophy, University of Maine.

Curtis, W. C., professor of zoology, University of Missouri.

Davis, Sarah Ellen, 512 West 132d Street, New York City.

Derick, Carrie M., assistant professor of botany, McGill University.

Donaldson, H. H., professor of neurology, Wistar Institute of Anatomy and Biology, Philadelphia.

Dodds, Gideon S., instructor in zoology, University of Missouri.

Drew, Gilman A., assistant director, Marine Biological Laboratory.

Duggar, B. M., professor of plant physiology, Cornell University.

Dungay, Neil S., professor of biology, Carleton College, Northfield, Minn.

Dunn, Elizabeth H., instructor in anatomy, University of Chicago.

Eddy, Milton W., Northwestern University.

Ennis, Agnes, 453 Convent Avenue, New York City.

Ferguson, J. S., assistant professor of histology, Cornell University Medical School, New York City.

Fox, Henry, professor of biology, Ursinus College, Collegeville, Pa.

Glaser, O. C., assistant professor of zoology, University of Michigan.

Goldfarb, A. J., instructor in zoology, College of the City of New York.

Harvey, Basil C. H., assistant professor of anatomy, University of Chicago.

Harvey, E. Newton, Columbia University.

Hogue, Mary J.

Just, E. E., Howard University, Washington, D. C.

Kelley, Frank J., assistant in experimental breeding, University of Wisconsin.

Kellicott, William E., professor of biology, Goucher College.

Knower, H. McE., professor of anatomy, University of Cincinnati.

Knudson, Lewis, instructor in plant physiology, Cornell University.

Lefevre, George, professor of zoology, University of Missouri.

Lewis, Ivey F., professor of biology, Randolph-Macon College.

Lillie, Frank R., professor of embryology, University of Chicago.

Lillie, R. S., instructor in physiological zoology, University of Pennsylvania.

Loeb, Jacques, Rockefeller Institute for Medical Research, New York City.

Lyman, George R., assistant professor of botany, Dartmouth College.

Lyon, Mary B., instructor in zoology, Mount Holyoke College.

McClung, C. E., professor of zoology, University of Kansas.

Mackenzie, Mary D., associate professor of biology, Western College, Oxford, Ohio.

Mathews, Albert P., professor of physiological chemistry, University of Chicago.

Mathews, Samuel A., assistant professor of experimental therapeutics, University of Chicago.

Mayer, Alfred G., Carnegie Institution, Washington, D. C.

Meigs, E. B., fellow in physiology, Wistar Institute of Anatomy and Biology, Philadelphia.

Montgomery, T. H., Jr., professor of zoology, University of Pennsylvania.

Moore, George T., professor of botany, Washington University, St. Louis.

Morgan, T. H., professor of experimental zoology, Columbia University.

Morse, Max W., professor of biology, Trinity College, Hartford, Conn.

Newman, H. H., associate professor of zoology, University of Chicago.

Osterhout, W. J. V., assistant professor of botany, Harvard University.

Packard, Charles, assistant in zoology, Columbia University.

Paton, Stewart, lecturer in biology, Princeton University.

Patterson, J. T., adjunct professor of zoology, University of Texas.

Pike, Frank H., instructor in physiology, University of Chicago.

Quackenbush, L. S., 27 West 73d Street, New York City.

Rea, Paul M., professor of biology, College of Charleston.

Rogers, Charles G., professor of physiology, Syracuse University.

Scott, John W., Westport High School, Kansas City, Mo.

Sink, Emory W., assistant in zoology, University of Michigan.

Spaulding, E. G., assistant professor of philosophy, Princeton University.

Spencer, Henry J., graduate student, Columbia University.

Strong, O. S., instructor in anatomy, College of Physicians and Surgeons, New York City.

Tashiro, Shiro, student, University of Chicago.

Thomas, Mason B., professor of botany, Wabash College.

Wallace, Edith M., Columbia University.

Wasteneys, Hardolph, assistant, Rockefeller Institute for Medical Research, New York City.

Whitney, David D., associate professor of zoology, Wesleyan University, Middletown, Conn.

Wieman, H. L., assistant professor of zoology, University of Cincinnati.

Wildman, E. E., professor of zoology, Central High School, Philadelphia, Pa.

Wilson, E. B., professor of zoology, Columbia University.

Woodruff, L. L., assistant professor of biology, Yale University.

THE UNIVERSITY OF TEXAS

At the annual meeting of the Alumni Association, held June 12, 1911, Mr. Will C. Hogg, of Houston, introduced the following resolutions, which were unanimously adopted by the Association:

Resolved, That the president of the University of Texas, Dr. S. E. Mezes, and the president of the Alumni Association, Mr. E. B. Parker, and such another gentleman as those two may select, be and are hereby appointed a committee of three to formulate and adopt for this association by-laws or rules defining the purpose of the organization of the permanent standing committee, and such by-laws and regulations adopted by the subcommittee of three herein authorized, are hereby adopted and made a part of this resolution as if read and carefully considered in advance at this meeting. Be it further

Resolved, That a committee composed of the presi-

dent of the University of Texas, the present president of the Alumni Association, the president of the board of regents of the University of Texas, are hereby instructed to proceed, in their own way, to the selection of a permanent standing committee of nine of ways and means for the enlargement, expansion, and extension of the University plan, and that the first meeting of said committee, if possible, be convened in the city of Austin on the first Saturday in October, 1911. Be it further

Resolved, That the President of the University of Texas, the present president of the Alumni Association of Texas and the president of the board of regents of the University of Texas be requested to select and authorize some suitable individual who will undertake, without any remuneration or expense, to provide a fund of not less than $25,000 per year nor more than $50,000 per year during the period of five years, payable in advance, in five equal annual installments of not less than $25,000 per year nor more than $50,000 per year, on the first day of October, 1911, 1912, 1913, 1914 and 1915.

The objects of these resolutions are described as follows:

1. To stimulate thought and create and arouse aspiration for higher education in Texas.

2. To attract the best thought and attention of aspiring persons engaged in educational work throughout the United States and Europe.

3. To inform the people of Texas that the organization, through the committees, is going to investigate, deliberate upon and advise the people of Texas what the extent of the physical institution should be, and what adequate means of maintenance should be provided. This is the restricted office and purpose of the organization which will be accomplished by the application of modern business and scientific methods of inquiry, investigation and determination.

4. The conception and definition of a curriculum, thorough-going and modern in all its details, comprehending the various activities of a modern commonwealth organization.

The following awards are proposed:

1. The award of a cash prize of $10,000 or more to architects for the best landscape and building design which will be the physical expression of the state's aspiration for higher education, and a second prize or prizes of $5,000 or more for the best thesis or theses on a properly assigned subject involved in the general educational design. It is probable that the competition in these classes will be limited to architects and professional educators of high reputation and that it will be closed for entry on or before January 1, 1913, all designs and theses to be filed on or before January 1, 1914. It is intended that such competitors shall have at least two years during which to prepare their designs and theses in this competition.

2. An annual prize of $500 or more for the best thesis on a selected and assigned topic involved in the general design of the movement, competition to be limited to graduating students of the University of Texas, awards to be made in October each year of the five-year period.

3. An annual prize of $500 or more, in the discretion of the committee, for the best thesis on a duly assigned topic involved in the general design, the competition to be limited to citizens of Texas other than graduating students of the university, awards to be made in October each year of the five-year period.

4. An annual prize of $500 or more for the best thesis on an assigned subject involved in the general design of the movement, the competition to be limited to graduating students of ten accredited universities of other states of the United States, of two colleges in Canada, of two in England, of one in Scotland, of two in Germany and of one in France.

SCIENTIFIC NOTES AND NEWS

THE Astronomical and Astrophysical Society of America met at Ottawa, Canada, from August 23 to 25. The officers elected are: E. C. Pickering, *president;* E. B. Frost, *first vice-president;* W. W. Campbell, *second vice-president;* W. J. Hussey, *secretary;* C. L. Doolittle, *treasurer;* J. S. Plaskett and W. S. Eichelberger, *councillors.* The next annual meeting will be held at Allegheny Observatory in August, 1912. The society will also meet

at Washington in December, in connection with the meeting of the American Association for the Advancement of Science.

THE annual Herter lectures will be delivered at the Johns Hopkins University on October 4, 5 and 6, by Professor Dr. Albrecht Kossel, of the University of Heidelberg, who was awarded the Nobel prize last year for his discoveries in medical chemistry.

THE German emperor has conferred on Sir William Ramsay the order "Pour le Mérite."

DR. JACQUES LOEB, of the Rockefeller Institute for Medical Research, has been elected a member of the Academy of Science in Cracow. Dr. Loeb has sailed for Europe to make an address before the Congress of Monists to be held in Hamburg.

AT the July meeting of the Spanish Society of Physics and Chemistry of Madrid, Professor Alexander Smith, of Columbia University, was elected an honorary member of the society.

AT its last commencement, the State University of Iowa bestowed the degree of doctor of laws on Professor William H. Norton, professor of geology, Cornell College, Iowa.

PROFESSOR JOHN B. EKELEY, head of the department of chemistry at the University of Colorado, was recently appointed state chemist by the state board of health. In June the honorary degree of doctor of science was conferred on him by his alma mater, Colgate University.

MR. D. E. HUTCHINS, chief conservator of forests, British East Africa, after ten years' forest service in India, twenty-three in South Africa and four in equatorial Africa, has retired on a pension.

R. H. BAKER, Ph.D. (Pittsburgh, 1910), has been appointed director of the Laws Observatory, University of Missouri.

DR. JAMES R. WEIR, Ph.D. (Munich), has been appointed an expert in forest pathology in the Bureau of Plant Industry.

MR. J. ALLAN THOMSON has been appointed paleontologist to the Geological Survey of New Zealand.

DR. N. L. BRITTON and Mrs. Britton are for a month at the Royal Gardens, Kew, England, in continuation of their studies on the flora of the West Indies.

MR. S. H. BURBURY, F.R.S., distinguished by his work in mathematical physics, died on August 18, at eighty years of age.

NEXT year the American Geographical Society celebrates its jubilee, and in connection with this event a transcontinental excursion for the purpose of geographical study is planned, under the leadership of Professor W. M. Davis. The start from New York, by special train, will take place some time in August, and the excursion will conclude in October, its duration being six or seven weeks.

THE South Australian Cabinet has decided to contribute £5,000 towards the cost of the Mawson Antarctic Expedition.

LETTERS have been received from Messrs. Vilhjalmur Stefansson and Rudolph M. Anderson, the Arctic explorers sent out three years ago by the American Museum of Natural History. A letter from Mr. Stefansson tells of the hazardous journey he undertook east from Cape Parry to the Coppermine River region, as far as Coronation Gulf. He discovered a tribe of Eskimos with fair complexions, white hair and red beards—these may be, he thinks, the descendants of the lost Scandinavians, who disappeared several centuries ago. He found also a primitive people, using stone implements, who could not count above five, and wiped from the map the Le Ronciere River. A letter from Mr. Anderson records his observations, chiefly of Arctic birds and animals, on his trip westward to Langton Bay.

AT the 1909 meeting of the International Mathematical Congress, held at Rome, the subject of mathematical teaching was brought forward, as *Nature* reminds us, and upon the initiative of Professor D. E. Smith, U.S.A., it was decided to form an International Commission on the Teaching of Mathematics, this commission to report to the next triennial meeting of the congress, which will be held at Cambridge (England) in 1912. The commis-

sion will meet at Milan on September 18–20 of this year to take stock of the work done so far.

The first all-Russian congress of women of academic education will be held in November of this year in St. Petersburg.

The U. S. Public Health and Marine-Hospital Service has just issued a series of nine wall charts illustrating the anatomy and life-history of hookworms, the methods of their dissemination, methods of prevention and pictures of severely infected patients. These charts are intended for use in schools, colleges and in field work. They are now being used by some of the state boards of health in the campaign for the eradication of hookworm disease. The charts are printed on heavy paper mounted on linen with wooden hangers and are sold by the Superintendent of Documents, Government Printing Office, Washington, D. C.

The State Geological Survey of Colorado, of which Professor Russell D. George, of the state university, is head, has three main parties in the field this summer. The first party, consisting of seven men, is under the direction of Assistant Professor Ralph D. Crawford, of the university. It is extending work begun in 1909 in the Monarch and Garfield area of Chaffee County to adjacent parts of Gunnison County. Professor Horace B. Patton, of the State School of Mines, heads a party at work about Alma, near Leadville. Under the direction of Professor F. F. Grout, of the University of Minnesota, a third party is doing rapid reconnaisance work in the Rabbit Ear Range in Routt and Grand counties. A study of the mineral and hot springs of the state is another activity of the survey. Mr. Roy M. Butters, of the university, and Mr. Frank Slattery, of the School of Mines, are visiting all the important springs.

For the first time the coal mines of the United States in 1910 were credited with an output exceeding half a billion short tons, the combined production of anthracite, bituminous coal and lignite having amounted to 501,576,895 short tons. This great output was attained in spite of the fact that most of the mines in Illinois, Missouri, Kansas, Arkansas and Oklahoma were closed for nearly six months by one of the most bitterly contested strikes in the history of the industry. The heaviest tonnage mined in any year previous to 1910 was in 1907, when a total of 480,363,424 short tons was produced.

Of the nineteen mines producing quicksilver in the United States in 1910, fifteen are located in California, two in Nevada and two in Texas, according to H. D. McCaskey, of the United States Geological Survey. The production in 1910, as obtained from confidential returns to the Geological Survey by every producer in the country, was 20,601 flasks of 75 pounds each. At the average domestic price at San Francisco, $46.51 a flask, the value was $958,153. As compared with the production of 1909, which was 21,075 flasks, valued at $957,859, this shows a decrease in quantity of 474 flasks but an increase in value of $294. Although the production of California increased in 1910, the output from Oregon decreased to nothing, as that of Arizona did in 1909, the small Nevada production fell off considerably, and the output from Texas decreased. In no state, except possibly Nevada, can an increased output be expected for 1911, the present outlook being for a total production for the United States not exceeding 20,000 flasks. A good domestic demand for quicksilver was noted throughout 1910. The principal uses are for gold milling and placer mining, for the manufacture of vermilion, fulminates, physical instruments, and drugs, and for lighting. The use of quicksilver in making the fulminate of percussion caps for igniting powder is increasing in importance probably more than any other use. The imports of quicksilver for domestic use are now nominal, having been in 1910 only 667 pounds, valued at $381, although the values of the imports in the preceding three years varied from $6,000 to $8,000. The exports of quicksilver in 1910 were 144,237 pounds, valued at $91,077, against 510,141 pounds, valued at $266,243, in 1909. The chief market is now Canada, followed by Mexico. The world's production of quicksilver in 1910 was 3,399

metric tons of 2,204.6 pounds each, against 3,304 tons in 1909, 3,296 tons in 1908 and 3,307 tons in 1907. Spain is the largest producer, furnishing nearly a third of the total world's supply from the famous Almaden mines. The United States, Austria-Hungary and Italy have in turn held second place, this country ranking third in 1910.

THE *Geographical Journal* states that Mr. Egon F. Kirschstein—a Russian by birth though living in Berlin—who accompanied the Duke of Mecklenburg on his journey across Africa in 1907–08, and did good work there by his investigation of the Virunga volcanoes, is about to undertake a new expedition to Central Africa, this time on his own account. His route will be through Portuguese East Africa to Lake Nyasa, and thence to Tanganyika and northwards along the frontier of the Belgian Congo to the Nile, thus touching in part his old area of investigation near Lake Kivu. The duration of the new expedition will probably be between one and two years. A considerable stay will be made in the district between Lakes Nyasa and Tanganyika, which it is proposed to traverse in all directions. Among other items, the ascent and geological investigation of the little-known Konde volcanoes near Lake Nyasa, as well as a visit to the Rukwa valley, are planned. The scientific collections are destined for the museums in Berlin, Brussels and St. Petersburg.

THE *Journal* of the American Medical Association supplies the following figures regarding the number of medical college graduates in the United States.

Year	Regular	Homeopathic	Electric	Physio-Med.	Nondescript	Total
1880	2,673	380	188	...	...	3,241
1890	3,853	380	221	...	...	4,454
1900	4,715	413	86	...	...	5,214
1901	4,879	387	148	18	12	5,444
1902	4,508	336	138	16	11	5,009
1903	5,088	420	149	24	17	5,698
1904	5,190	371	146	20	20	5,747
1905	5,126	276	153	22	23	5,600
1906	4.841	286	186	22	29	5,364
1907	4,591	225	121	11	32	4,980
1908	4,370	215	116	12	28	4,741
1909	4,163	209	84	15	44	4,515
1910	4,113	183	114	16	14	4,440
1911	4,006	152	110	5	...	4,273

CAPTAIN PÉRIQUET has returned to France after completing his surveys in French Equatorial Africa along the line of a possible railway from the coast to the interior. According to the *Geographical Journal* he professes himself convinced of the value and feasibility of such a line, which would tap a rich region of virgin forest abounding in rubber-yielding plants. Besides fixing fifty-four new positions, Captain Périquet and his coadjutors carried out route-surveys totalling some 3,000 miles, paying much attention also to the determination of levels. The traveler was much impressed by the intelligence and general character of the western Pahuins (Fans), who are said to be the most interesting people of the territory, fully equalling the Senegalese in their adaptability to civilization.

THE U. S. Geological Survey has made public figures prepared by Mr. J. P. Dunlop, showing the recovery of "secondary" copper, lead, zinc, tin and antimony in 1910. The total amount of secondary copper recovered, on the assumption that the brass remelted had an average copper content of 70 per cent., was 91,500 tons, of which 15,500 tons was recovered by regular refining plants and the remainder by plants treating only secondary material. At least 30,000 tons was recovered from clean scrap made in the course of manufacture of copper and brass ware, so that only 61,500 tons was obtained from ashes and cinders and from material that had entered the trade in manufactured form and been discarded. The survey inquiry was extended so as to include the railway companies' figures for old metals reused by themselves, and to these is attributed a large proportion of the increase in the figures for copper. The production from secondary sources in 1910 was equal to about 17 per cent. of the domestic consumption of new copper. The secondary lead was equal to 11.5 per cent. of the refined lead produced in the United States. The secondary zinc equaled 23.2 per cent. of the total production of primary spelter in the United States. The secondary antimony shows a large increase, and, as the production from domestic antimonial and antimonial lead ores

was comparatively small, the secondary recoveries are the only important domestic source of supply. The production of tin from ore mined in the United States is negligible, so that the secondary recoveries constitute practically the sole domestic supply. The use of old tin cans as a source of tin was not extended. The cost of collecting, transportation charges and inability to dispose of the old black plate from which the tin is wholly or partly removed are the principal reasons given why more old tin cans are not utilized.

UNIVERSITY AND EDUCATIONAL NEWS

The daily papers state that there will be established at Ragland, Ala., an industrial school for white children by the Southern Board of Education with funds amounting to $5,000,000 to be given by Mr. John D. Rockefeller, the Russell Sage Foundation, Mrs. E. H. Harriman and others. Ragland offered 5,000 acres for the site, 200 lots in town, water power and other considerations.

Dr. S. N. Kolaceoskij, who died recently, bequeathed all his property, estimated at 40,000,000 rubles, for the establishment, in southern Russia, of an agricultural academy.

Concrete foundations have been completed for Rand Hall, the new Sibley shop building, of Cornell University, and steel for the framework is arriving on the premises.

As previously announced, the inauguration of Dr. Guy Potter Benton as president of the University of Vermont will take place on the fifth and sixth of October. Following the general plan already given, the formal inauguration exercises will take place on the second day. The first day will be given to a conference between colleges and secondary schools on the subject, "College Requirements and the Secondary Curriculum."

Carbon Gillaspie, M.D. (Colorado), has been appointed professor of anatomy in the University of Colorado. Since 1909 Dr. Gillaspie has been instructor in this department. He will give all his time to teaching.

Mr. William J. McCaughey, mineralogist and petrographer of the U. S. Bureau of Soils, has been appointed as assistant professor in metallurgy and mineralogy in the Ohio State University.

P. F. Gaehr, Ph.D. (Cornell), formerly of Robert College, Constantinople, has been appointed professor of physics at Wells College, Aurora, N. Y.

Additions to the faculty of the Agricultural College of Utah for the year 1911–12 are as follows: E. G. Titus, Sc.D. (Harvard), professor of entomology; F. L. West, Ph.D. (Chicago), professor of physics; Elmer G. Peterson, A.M., Ph.D. (Cornell), professor of bacteriology; F. S. Harris, Ph.D. (Cornell), professor of agronomy; C. N. Jensen, M.S.A. (Cornell), professor of botany and plant pathology; J. E. Greaves, Ph.D. (California), associate professor of chemistry; and W. E. Carroll, M.S. (Illinois), assistant professor of animal husbandry. J. C. Hogenson has been transferred from college work to the extension division as agronomist. The extension division has been enlarged further by employing Miss Hazel Love Dunford for work in home economics.

Dr. A. N. Whitehead, F.R.S., fellow of Trinity College, Cambridge, has been appointed to succeed Mr. E. Cunningham, as lecturer in the department of applied mathematics and mechanics in the University College, London.

DISCUSSION AND CORRESPONDENCE

MOISTURE AND OUT-OF-DOORS

To the Editor of Science: This being the deadest time of the year, when nobody reads Science, and the post-office refuses to send it after one, I am emboldened to take my pen in hand. The two very clear letters by Messrs. Mott-Smith and Wilson, in answer to Dr. L. H. Gulick's query regarding moisture in the air, together with those of Messrs. Kent, Crowell and Jones in the issue of March 31, leave little or nothing to be said on the subject. What I wish to emphasize is the feeling of shock that I experienced when a medical man of the standing of Dr. Gulick could ask such questions in good faith, when, as has been said, the answers to them can be

found in any treatise on physics. Taking the one which happens to be nearest my hand, that of Magie, I find the subject treated completely in four pages. The point I wish to make is that these matters are taught in freshman courses. But who takes these courses? There is the rub. Of course we know that all engineering students are compelled to take courses in physics. We also know that most chemists take them. Some now even take courses in mathematics, and when a chemist gets a control of mathematics, we know how he makes mathematics hum! One would expect that every medical student would be required to take a course in physics. In other countries this is so. I remember how the elementary courses of Helmholtz and Kundt were so choked up with "Mediziner" as to cause them to grumble. But I fancy that in this country things are here as elsewhere, somewhat at loose ends. A few years ago I remember hearing an address by Dr. Welch on the relations of medicine to physics, so clear, so luminous, so interesting, so learned that it seemed to me that no other medical man in the country could have given it, and I thought, fortunate is the medical school that has such a teacher! But why should not everybody desiring to be liberally educated study physics? I do not stop to give the reasons, everybody that is liberally educated knows them. And yet we see chemists, psychologists, physiologists, microscopists and many others, every one of whose tools is physical, ignorant of this fundamental science and its methods, and the intelligent man in the street is asking whether the drought is due to the great increase of electric railroads! And how many of our colleges require everybody to take a course in physics? I can not answer this definitely, but I know of only one, Princeton, and I will say to the honor of that institution that I was told that this was the only subject on which the faculty was unanimous.

But Dr. Gulick's letter is on a very important subject, on which an enormous amount depends, and on which little seems to be known. The question is, briefly, what is the advantage of out-doors over in-doors? All I can contribute to this is a little scientific common-sense. If it is due to the air, as seems implied by most writers, what properties has the air? These can be of only three kinds: first, physical; second, chemical; third, biological. The physical properties are very simple and easily investigated. They are its temperature, pressure and density, and the density of water vapor in it. To these I venture to add its ionization. No discussion is now complete without some mention of ions, so put that in. Do not forget the sunlight. The chemical aspect is simple and consists only in the knowledge of the amounts of the various gases present. Finally, there is the question of what and how many microorganisms are present. This, the most difficult and perhaps the most important of all, we may turn over to the biologist. Dr. Gulick, who says that he has digested all the literature found in the bibliographies, says that "we know definitely" that there is no such thing as a subtle human poison (anthropotoxin) which varies in proportion to the CO_2. Very well, but, to use the vernacular, "they tell me different."

As an illustration of what I have said, consider what happens when a man smoking a cigar comes into my neighborhood. The first impression that I get is a sense of filth (stink is what the Bible says). This is psychological, and I will not go into it. Then I realize that the chemical equilibrium of the atmosphere has been destroyed, and that a foreign physical body has been introduced, though whether the pressure of the air has been altered I can not say. Also whether there is an anthropotoxin present I can only query, although I know one *anthropos* that is immediately toxized.

Now for the question, what *is* out-doors? Obviously the question of doors and walls is not the main thing. We know that, *ceteris paribus*, the same effects will follow. The only question is as to what "ceteris" *are* "paribus." Does any one doubt that, if the air is physically, chemically and biologically (microorganisms) the same indoors and out, the physiological effects will be the same?

Why, the thing has never been tried! In the name of suffering humanity, let us try it, in the manner suggested by Professor Kent. I have not the slightest doubt that the superiority of out-doors for the health is due to the fact that it is impossible in-doors to secure the circulation of the air that will continually remove the noxious products and replace the air with absolutely good air. Again look at the smoker. It is with difficulty that you can get him to smoke in the open air. It takes away his filthy chemical, and he will often admit to you that at night, and out-of-doors, he can not tell whether he is smoking or not. Thus he gives his whole case away, and helps me in my argument.

There is one other thing that we must not overlook, and that is the sun. I dare say that in spite of all we might do to the air, if we did not pass it out into the sun we should not accomplish much. What does the sun do to the air? Photochemistry will have to answer this, and it soon will. And finally remember that the conditions of radiation of heat from our bodies are totally different when we are surrounded by walls and when not. The question of out-doors is, accordingly, not a simple one, but is composed of simple parts. Let us attack it in detail. Perhaps it will be answered before the other equally important one, *Shall we wash?* And this reminds me of a passage in Dr. Gulick's letter which I can not let pass. In a well ventilated school-room (in London) there was "no smell of human beings—this was only noticeable when one stood among the *boys*" (italics mine). As an ex-boy I resent this.[1]

Finally let me suggest an answer to Mr. Mott-Smith's last question: "Why is a little sneaking draught in the house a source of colds and grippe, while a high wind out-of-doors a pleasure and a benefit?" I suspect that the answer will be Mr. Dooley's consoling one to Hennessey, "It ain't so!"

ARTHUR GORDON WEBSTER
WORCESTER, MASS.,
August 4, 1911

[1] It has occurred to me that perhaps it was a boys' school.

ELECTRONS

TO THE EDITOR OF SCIENCE: Will you permit an old fogy to trespass on your space long enough to ask a simple question? I confess that in spite of bibliographies, card catalogues, scientific management and all the helps to the weary, I have lately found it impossible to keep up, and find myself confronted with the horrid thought of having to become a specialist. I have not even been able to read all that the chemists have written about physics. Now whether we agree with what has recently been said by a notorious chemist (perhaps I mean noted, but the weather is so hot) that "we appreciate fully that physics, geology, engineering, physiology, medicine, botany, zoology and biology (why not astronomy?) are subdivisions of the broader science of chemistry, we see that the chemist of the future must know a great deal more than any of us do now"—whether we agree with this poet or not (and I cordially agree with his final statement) we know that in future the physicist has got to sit at the feet of the chemist (I hope he will sit *on* them). But in Professor McCoy's very interesting article on metals I find the following statement, which causes me some difficulty: "The charge of the electron is negative in sign. In fact we have decisive experimental evidence of only this one kind of free electricity, positive electrification of a body being from this standpoint merely a deficiency of electrons. J. J. Thomson has shown how from the conception of an atom made up of electrons rotating in a sphere of positive electrification, there follows," etc. Now I submit that logically the above statement would be helped by a substitution in the last sentence of the definition from the next to the last, so as to read: "an atom made up of electrons rotating in a sphere of merely a deficiency of electrons," etc. What I want to know is, what is this spherical deficiency made of? Is it a hole in a space all full of electrons? If so, what about the lonely electrons rotating in this hole in the whole body of electrons? But perhaps

I have not got it right. This is hot weather anyhow. I presume the passage in "quotes" is from some of Sir J. J. Thomson's writings. I do not want Dr. McCoy to think that I am blaming him. But if so, what are all these papers of Thomson's and Wien's on positive rays about? Being an old fogy, I sometimes feel that there are too many electrons about, and that one of the wonderful fly-traps that you read so much about in the papers ought to be devised to catch them. I remember (dimly) that when I was a boy in college I had a great aversion to molecules. I had never seen one, and didn't like them. And now I have the same queer feeling about electrons. But perhaps I shall see one some day. Rutherford has. But the one he saw was positive. Wasn't it? I am not positive.

Speaking of chemists, I think the best joke ever made by a chemist was when Mendelejeff undertook to consider the ether as a chemical element! Why not have the ether made of electrons? To which of these hypotheses should we incline? I answer in the words of Dr. Holmes, "To ether."

ARTHUR GORDON WEBSTER

WORCESTER, MASS.,
August 4, 1911

THE SCIENCE OF GOVERNMENT

TO THE EDITOR OF SCIENCE: Investigations are the order of the day, not only by scientific men, but (save the mark) by Congress. Your quotation from the *Independent* with regard to Dr. Wiley encourages me to express the hope that this incident may lead to an investigation (by both classes of persons) of the whole question of the relation of the government to science. Every interest in the country that has votes enough and can log-roll enough support is looked after by the government, and eventually gets a cabinet officer, why not science? I suppose there is no doubt that our government spends more on science than any other. I suppose there is equally no doubt that it gets less for its money than any other, and that there are many abuses unworthy of a civilized régime which ought to be abolished. Of these the chief one is, why are not scientific affairs managed by scientific men? I suppose it is because members of congress do not believe that scientific men are worth more than $9 a day. As long as scientific men are willing to tolerate such an assumption I do not much blame the congressmen.

But there is another reason, hinted at in your quotation. It is that the atmosphere of Washington is not only rotten (I have treated the atmosphere elsewhere) for science, but it is infested with a most dangerous parasite, the *red-tape-worm*, I do not rightly know whether to call it a protozoan, a microtome, or a cytoblast, but either Dr. Charles Hookworm Stiles or Dr. L. Culex Howard can tell. This worm eats the vitals out of the scientist, and leads him to pretend that he didn't do the research, but that the man higher up did. Washington is a charming city, full of statues of men on horseback, waving cocked hats, but when every scientist has to have an assimilated rank, so that he shall know whether he is a captain or a major-general, the results can only be painful. I am glad that I did not coin the phrase, "Washington Science," and equally glad that some one else did. By the way, not all Washington science is done under the government. I hope this letter may provoke discussion, but I do not wish to take part in it. Like all brave anarchists, I wish merely to explode the bomb, and then run like . . . . !

ARTHUR GORDON WEBSTER

WORCESTER, MASS.,
August 4, 1911

DUE—

TO THE EDITOR OF SCIENCE: Due to the death of my imaginary stenographer, I am able to write you but a few lines. This is a quotation from any one of several hundred scientific contributions that I have read lately. The object of my writing now, Mr. Editor, is to ask of you (for the first time) a favor, and that is that you will refuse to print any communication in which the adjective "due" appears in any way except as agreeing (I think that is the word) with some noun or pronoun. As I believe that one who does not do research himself may do good by suggesting subjects

to others I suggest this. "Which is the worse, the English of scientists or of politicians?" *Will* and *shall* barred.

Arthur Gordon Webster

Worcester, Mass.,
August 4, 1911

SCIENTIFIC BOOKS

A History of the Theories of Æther and Electricity from the Age of Descartes to the Close of the Nineteenth Century. By E. T. Whittaker. London, Longmans, Green & Co.; Dublin, Hodges, Figgis & Co., Ltd. 1910. Pp. xiv + 475.

In this excellent volume, the Royal Astronomer of Ireland traces the development of our ideas concerning the nature of the ether and of electricity, as expressed by the various theories which have been proposed from time to time about these entities.

The treatment includes an account of those discoveries in light, electricity and magnetism which have been influential in shaping and supporting theory, and these facts are interwoven with the discussion of the theories themselves in such a way that a historically continuous narrative results. Everything is made subservient, however, to the explanation of the theories themselves. These are discussed at sufficient length to bring out their chief features, and often too their limitations are noted. The discussions are not confined to verbal description, but preference is given rather to a deeper treatment from the mathematical side. The book is intended, therefore, mainly for the advanced student who alone is in a position to go into the details of the subject.

The work opens with a chapter on the theory of the ether in the seventeenth century, covering a period in which the wave theory of light had but begun to receive attention. The next two chapters deal with the fundamental discoveries in electrostatics and about steady currents in conductors, and with the earlier electrical theories. Then come two chapters on the ether in that period when the wave theory of light had its greatest development, although light was still not associated with electrical action.

The following five chapters, beginning with one on Faraday, cover a half century in which attention was directed more and more upon the action in the dielectric surrounding a conductor, which finally resulted in the electromagnetic theory of light. The two closing chapters deal chiefly with the rise of the theory of electrons and the part they play in optical and electrical phenomena.

The book will be welcomed by all physicists as a valuable contribution. J. Z.

The Social Direction of Human Evolution: An outline of the science of Eugenics. By William E. Kellicott. New York, D. Appleton & Company. 1911.

William Morris once said that a cause, in winning its way to acceptance, had to pass through three stages: first, all men ignored it; second, all men opposed it; third, all men accepted it. The cause of eugenics has survived the first stage without really entering upon the second. It even seems possible that it may contrive to skip a considerable part of the second stage of the metamorphosis, and enter into its heritage with little opposition. It is much too early, however, to confidently predict anything of the sort, and it may be necessary to go through troublous times, if only to arrest the attention of an easy-going and unscientific public.

Just now, the time is not ripe for an extended work on eugenics, but, on the other hand, the moment is opportune for the appearance of a little book such as that of Professor Kellicott. Not long ago, Dr. C. B. Davenport issued a very convenient little pamphlet, which has been widely read. Professor Kellicott's book is larger, but has a similar aim, both being admittedly ephemeral works intended to inform the general public. Now that interest has been aroused in several quarters, and important investigations bearing upon the subject are being made, a new book, or a new edition of an old one, will be needed perhaps nearly every year for some time to come. The volume before us will excellently serve present needs, and perhaps as the necessity arises its author will prepare

other editions, keeping it abreast with the times. From the brevity of the treatment and the propagandist aim, it results that the statements given are in some cases rather more confident or dogmatic than the facts known to us may warrant. In particular, I should have wished to look a little more cautiously over some of Karl Pearson's results, such as those on the inheritance of mental traits and on the greater susceptibility to disease of the first born in a family. Broadly speaking, however, the arguments are sound and well presented, and any non-scientific person reading and accepting them as they stand will not go far astray.

The first chapter, on "the sources and aims of the science of eugenics" begins with a summary of the history of the subject, and goes on to discuss the relations of biology to sociology, giving some of the sociological data which are important for the "eugenist." The second goes into the biological foundations of eugenics, and gives a condensed account of the main facts concerning variation, heredity and kindred matters. In the description of the Mendelian phenomena, the first case given is one (the Andalusian fowl) in which the heterozygous form is unlike either of the homozygous ones. This reverses the usual order, with I think distinct advantage, making the matter clearer and showing from the start that dominance is not essential to Mendelism. The third and final chapter is a long one on human heredity and the eugenic program. In it are given many striking human pedigrees, and much other information likely to astonish many readers. On page 200, in discussing the inheritance of acquired characters, the "giraffe's neck and the fox's cunning" are classed among these, by some slip or ambiguity. In connection with this matter we may perhaps question the practical limitation of the concern of the eugenist (pp. 42–43) to "conditions which affect the innate characteristics of the race," as it is obvious that improved social conditions will tend to bring out or make visible desirable innate qualities, which may then be considered successfully from the standpoint of eugenics.

The author rightly insists that a large part of the present eugenic program is educational. Scientific men who are of this opinion can do something for the cause if they will help to circulate Professor Kellicott's book.

T. D. A. COCKERELL

Animal Intelligence. By Professor E. L. THORNDIKE, Columbia University. New York, The Macmillan Co. 1911. Pp. viii + 297. $1.60 net.

Students of behavior, biologists and experimental psychologists, alike, welcome the volume containing the collected papers on animal psychology of Professor E. L. Thorndike which has just been published in the Animal Behavior Series.

For some years the most important two of the papers, "Animal Intelligence" and "The Mental Life of Monkeys," published originally as Monograph Supplements to the *Psychological Review,* have been out of print. Since Thorndike's studies marked the dawn of the experimental era in animal psychology it is distinctly worth while to have this material in convenient form and available for students for years to come. The historical value of the work, however, is not the chief reason for the publication of the volume. However much the technique and scope of animal psychology may have advanced since the first appearance of Thorndike's work, his penetrating discussions of the general nature of animal mind have by no means been outgrown. In looking back upon his work one is struck by the boldness and apparent rashness of his general conclusions, especially in view of the fact that his experimental material was limited; and yet those conclusions in the most essential points have stood the test of twelve active years.

J. B. WATSON

QUOTATIONS

SEVEN YEARS' PROGRESS IN MEDICAL EDUCATION

THOSE who have been watching the development of medical education in this country have noted with no little astonishment and gratification the remarkable progress that has been made in recent years and particularly

since the American Medical Association created its permanent committee, the Council on Medical Education. At the beginning of its work in 1905, after a thorough investigation of conditions the council formulated two standards of medical education, one for immediate adoption and an ideal standard for future consideration. These standards were not for any one state or for any one section, but for the entire country. The result is that nearly all colleges are up to or beyond the standard recommended in 1905 for "immediate adoption," while more than a third of the colleges (42) have, so far as entrance requirements are concerned, adopted the "ideal," namely, a four-year high school education, plus at least one year to include thorough courses in physics, chemistry, biology and modern languages.

During 1906 and 1907, the council made the first complete personal tour of inspection of the medical colleges of the United States that had ever been made, and in 1907, reported its findings at its annual conference and to the House of Delegates of the American Medical Association. This inspection revealed the fact that nearly a third of the medical schools existing at that time were seriously defective in their methods, standards and equipment. Since that report was made the decrease in the number of these inferior colleges has been marked, while, on the other hand, there has begun a corresponding improvement in many other colleges. The second inspection was completed in 1910, and resulted in the publication of a classified list of medical colleges. This doubtless gave added impetus to the improvements being made and to the further elimination of unworthy colleges. In seven years, therefore, the over-supply of medical schools has been reduced in number, quantity giving way to quality, and a decided check has been placed on the rapid multiplication of inferior schools.

In 1908 and 1909, a thorough study of the medical college curriculum was made by a special committee of the council, made up of over a hundred leading medical educators, to ascertain the relative value of the subjects of the curriculum in order that proper emphasis might be laid on them in the medical course. This special study also included the character of equipment, methods of instruction, qualifications of teachers, necessary hospital facilities, etc. As a result of this and the council's reports based on its actual inspection, an unprecedented improvement in the physical equipment and methods of medical education was started. New college buildings have been erected; more teaching hospitals have been secured; new laboratories have been equipped and more expert full-time teachers employed.

During each of the seven years the council has held a special, delegated conference attended largely by members of state licensing boards, university presidents, representatives of medical colleges and other prominent educators. These conferences have had a wide and powerful influence in the progress that has been made. They have resulted in more uniformity of effort on the part of all forces working for the betterment of educational standards and have provided opportunity for the study and discussion of educational problems. Above all, however, at these conferences, the attention of university presidents and others has been drawn to the absolute necessity of state aid or private endowment for medical schools. As a direct or indirect result of this campaign, the amount of money given for medical education has increased from a few thousands of dollars during 1904 to several millions of dollars during the last year. This is indeed encouraging and gives promise of even greater advancement in the immediate future.

Of course, not all the credit for these vast improvements belongs to the Council on Medical Education. Nevertheless this body, representing the organized profession of the country and holding up standards of national and not sectional scope, was bound to have a powerful influence. It has cooperated with the other agencies which have been doing masterly work in their various fields, and has brought about greater harmony and more unanimity of effort. These achievements are the more gratifying since all the agencies save one, the Carnegie Foundation for the Advancement of

Teaching, are entirely made up of physicians and fully represent the medical profession. Meanwhile, no one is better acquainted with the needs of the people in regard to the prevention and cure of disease and the preservation of health and healthful conditions than the medical profession itself. And that the medical profession may be even more capable of caring for these needs, nothing is more important than the continued improvement of medical education.—*Journal of the American Medical Association.*

SCIENTIFIC JOURNALS AND ARTICLES

THE contents of the *Journal* of the Washington Academy of Sciences for August are as follows:

Physics.—"Melting Temperatures of Sodium and Lithium Metasilicates," F. M. Jaeger.

"A Method for Determining the Density of certain Solids by means of Rohrbach's Solution having a Standard Refractive Index," H. E. Merwin.

Electricity.—"A Study of the Current Transformer with Particular Reference to Iron Loss," P. G. Agnew.

Geochemistry.—"Minerals and Rocks of the Composition $MgSiO_3$—$CaSiO_3$—$FeSiO_3$," Robert B. Sosman.

Mineralogy.—"Crystallized Turquoise from Virginia," Waldemar T. Schaller.

"Quartz and Fluorite as Standards of Density and Refractive Index," H. E. Merwin.

"The Temperature Stability Ranges, Density, Chemical Composition and Optical and Crystallographic Properties of the Alkali Feldspars," H. E. Merwin.

Petrology.—"A Micrometer Ocular with Coordinate Scale," Fred Eugene Wright.

"The Lavas of Hawaii and their Relations," Whitman Cross.

Paleontology.—"Remarks on the Fossil Turtles Accredited to the Judith River Formation," F. H. Knowlton.

Zoology.—"Remarks on the Nervous System and Symmetry of the Crinoids," Austin H. Clark.

Chemical Statistics.—"The Consumption of the Commoner Acids in the United States," Charles E. Munroe.

Abstracts.—Geodesy; Meteorology; Terrestrial Magnetism; Electricity; Radio-telegraphy; Chemistry; Electrochemistry; Agricultural Chemistry; Mineralogy; Geology; Botany; Forestry; Zoology; Conchology; Fisheries; Pharmacology; Bacteriology; Sanitation; Engineering.

Proceedings.—Washington Academy of Sciences.

SPECIAL ARTICLES

WHERE ARE THE LARAMIE DINOSAURS?[1]

THE Ceratopsidæ or horned dinosaurs have so long been regarded by paleontologists and others as belonging to the Laramie formation, and also that this "Laramie formation" containing them is of Cretaceous age, that facts which seem to oppose this view make but slow headway. That the true Laramie *is* of Cretaceous age no one is likely to question at this stage of the discussion, but the mistake lies in presuming that the dinosaur-bearing beds belong to the Laramie. At the Baltimore meeting of the Geological Society of America (December, 1908) I ventured to say, in a public discussion of one of the correlation papers, that there was no known locality in North America where dinosaurs (Ceratopsidæ) occur in true, undoubted Laramie. To the best of my knowledge and belief that statement still holds good.

In June, 1909, I published a paper[2] in which the following is given as the thesis: "The present paper deals with the extensive series of fresh-water deposits of the northwest (*i. e.*, broadly, the region east of the Rocky Mountains and between Wyoming and the valley of the Mackenzie River) comprising what is here considered as the Fort Union formation. It is shown that the Fort Union embraces more than has been commonly assigned to it. Conformably below the beds by some geologists considered as the true Fort Union occur dark-colored sandstones, clays and shales, which have often been incorrectly referred to the Laramie, or its equivalents, but which are stratigraphically and paleontologically dis-

[1] Published with the permission of the director of the U. S. Geological Survey.

[2] "The Stratigraphic Relations and Paleontology of the 'Hell Creek Beds' and Equivalents, and their Reference to the Fort Union Formation," *Proc. Wash. Acad. Sci.*, Vol. 11, 1909, pp. 179–238.

tinct from the Laramie, and the contention is here made that these beds, which include the 'Hell Creek beds' and so-called 'somber beds' of Montana, the 'Ceratops beds' or 'Lance Creek beds' of Wyoming, and their stratigraphic and paleontologic equivalents elsewhere, are to be regarded as constituting the lower member of the Fort Union formation and are Eocene in age."

In that paper it was shown that the dinosaur-bearing beds ("Ceratops beds") rest, in some cases unconformably, in others in apparent conformity, on Fox Hills or Pierre, and the conclusion was reached that an erosional interval is indicated during which the Laramie—if ever present—and other Cretaceous and early Tertiary sediments were removed. From this it follows that the beds under consideration, being above an unconformity, can no longer be considered as a part of the "Conformable Cretaceous series," and hence are not Laramie. It was also shown that these beds can not be separated on structural or lithologic grounds from the overlying acknowledged "yellow"-bed Fort Union; in other words, that sedimentation was continuous and uninterrupted.

The results of the work of two field seasons in critical areas have just been published (June, 1911),[3] showing that the results of the first paper are confirmed in every particular. For instance, on the North Platte River, opposite the mouth of the Medicine Bow River, in Carbon County, Wyoming, remains of *Triceratops* were found in beds (typical "Ceratops beds") *above* 6,000 feet of undoubted Laramie, and from which they are separated by an unconformity which, according to Veatch, has involved the removal of over 20,000 feet of strata. This would seem forever to dispose of the contention that the "Ceratops beds" are in any way the equivalent of the Laramie. A short distance to the northeast of this locality, in Converse County, Wyo., the Laramie is entirely absent and the dinosaur-bearing beds rest without observed unconformity on Fox Hills. In adjacent South Dakota and southeastern Montana these same beds rest on Fox Hills of varying thickness, often with obvious erosional unconformity, occasionally also with angular as well as erosional discordance, and, in one instance, apparently on Pierre, the whole of the Fox Hills being cut out.

In 1910 the U. S. Geological Survey formally adopted the name *Lance formation*[4] in place of "Lance Creek beds" or "Ceratops beds." Wherever *Lance formation* is employed it is to be understood as including "Lance Creek beds," "Ceratops beds," "Hell Creek beds," "somber beds," "Lower Fort Union" and dinosaur-bearing beds identified as "Laramie" by many writers.

At first the Lance formation was considered to be of Cretaceous age, though obviously above and distinct from the Laramie. Later, however, when the facts became known as above outlined, and when it became necessary to place the Lance formation officially[5] it has been recorded as "Cretaceous or Tertiary." This concession is regarded by the writer as important, and one the value of which is not to be overlooked.

The vertebrate paleontologists[6] continue to refer to the "Ceratops beds" as the "Laramie," the "Laramie Cretaceous," etc., as though nothing had been ascertained regarding their position since they were named twenty-five years ago! If there *is* valid evidence to show that the Lance formation ("Ceratops beds") is the equivalent of the Laramie in whole or in any part it would be welcome. If there *is* a known locality where dinosaurs (Ceratopsidæ) occur in the true Laramie, information concerning it should not longer be withheld.

F. H. Knowlton

[3] "Further Data on the Stratigraphic Position of the Lance Formation ('Ceratops Beds')," *Jour. Geol.*, Vol. 19, 1911, pp. 358–376.

[4] See first use, *Am. Jour. Sci.*, Vol. 30, September, 1910, p. 172.

[5] Cf. Bull. U. S. Geol. Surv., No. 431 B, 1911, p. 85.

[6] Cf. Lull, *Am. Jour. Sci.*, Vol. 29, 1910, pp. 1–39; Brown, *Bull. Am. Mus. Nat. Hist.*, Vol. 28, 1910, pp. 267–274; Wieland, *Am. Jour. Sci.*, Vol. 31, 1911, pp. 112–124.

SCIENCE

FRIDAY, SEPTEMBER 15, 1911

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE CHARACTERISTICS OF THE OBSERVATIONAL SCIENCES[1]

IT will doubtless startle my audience to hear that this section has only once in its history been addressed by an astronomical president upon an astronomical topic. I hasten to admit that I am not using the term astronomical in its widest sense. Huxley once declared that there were only two sciences, astronomy and biology, and it is recorded that "the company" (which happened to be that of the Royal Astronomical Society Club) "agreed with him." One may agree with the company in assenting to the proposition in the sense in which it is obviously intended without losing the right to use the name astronomy in a more restricted sense when necessary; and at present I use it in its classical sense. At Brighton, in 1872, Dr. De La Rue addressed Section A on "Astronomical Photography" in words which are still worthy of attention, though they are all but forty years old; and this is the only instance I can find in the annals of the section. There have, of course, been occasional astronomical presidents such as Airy, Lord Rosse and Dr. Robinson, but these presided in early days before the address existed, or when it was brief and formal; and the only allusions to astronomical matters were the statements, by Robinson and Airy, of what the association had done in subsidizing the reduction of Lalande's observations and the Greenwich lunar observations. In 1887 Sir Robert Ball occupied this chair, but he

[1] Address of the president to the Mathematical and Physical Section. Portsmouth, 1911.

selected from his ample scientific wardrobe the costume of a geometer, and left his astronomical dress at home. A great man whose death was announced almost as I was writing these words, Dr. Johnstone Stoney, spoke (in 1879 at Sheffield) of the valuable training afforded by the study of mechanics and of chemistry, with that keen insight which made him so valuable a member of our section. Other presidents whom we have been glad to welcome as astronomers at certain times and seasons did not choose the occasion of their presidency for any very definite manifestation of astronomical sympathy.

The addresses of Sir George Darwin (in 1886) and of Professor Love (in 1907) on the past history of our earth certainly have an astronomical bearing, but if we distinguish between the classical astronomy and its modern expansions they would be assigned to the latter rather than to the former; and so do the few astronomical allusions in Professor Schuster's address at Edinburgh in 1892. Even if we include, instead of excluding, all doubtful cases, there will still appear a curious neglect of astronomy by Section A in the last half century, all the more curious when it is remarked that the neglect does not extend to the association itself, seeing that there have been three astronomical presidents of the association who had not been previously chosen to fill this chair. The neglect is not confined to astronomy, but extends, as some of us recently pointed out, to the other sciences of observation; and we thought that, as a corollary, it would be better for the section to divide, in order that these sciences might not continue the struggle for existence in an atmosphere to which they were apparently ill-suited. But the section decided against the suggestion, and I have no intention of appealing against the decision. This explicit statement will, I trust, suffice to prevent misunderstanding if I proceed to examine the possible causes of neglect—for I can not but regard the record as significant of some cause which it will be well to recognize even if we can not remove it. Personally I think the cause is not far to seek, and my hope is to make it manifest; but as the statement of it involves something in the nature of an accusation, I will beg leave to make it as gently as possible by using the words of others, especially of those against whom the mild accusation is to be made.

Let me begin by quoting from the admirable address—none the less admirable because it was only one quarter of the length to which we have become accustomed—delivered by my late Oxford colleague, the Rev. Bartholomew Price, at Oxford in 1860, wherein he referred to the constitution of this section as follows:

> The area of scientific research which this section covers is very large, larger perhaps than that of any other; and its subjects vary so much that while to some of those who frequent this room certain papers may appear dull, yet to others they will be full of interest. Some of them possess, probably in the highest degree attainable by the human intellect, the characteristics of perfect and necessary science; while others are at present little more than a conglomeration of observations, made indeed with infinite skill and perseverance, and of the greatest value: capable probably in time of greater perfection, nay, perhaps of the most perfect forms, but as yet in their infancy, scarcely indicating the process by which that maturity will be arrived at and containing hardly the barest outline of their ultimate laws.

A little later in the address Professor Price made it quite clear which were the sciences "in their infancy."

> And finally we come to the facts of meteorology and its kindred subjects, many of which are scarcely yet brought within any law at all.

There is here much that will command ready and universal assent; but is there not also a rather unnecessary social scale? The

science of planetary movement had not yet been "brought within any law at all" (as we now use the term) in Tycho Brahé's time; but was the astronomy of Tycho Brahé socially inferior to that of Kepler? It is difficult to fix the eye on such a question without its being caught by the splendor of Newton towering so near; and the idea of a scale descending from that great height is almost irresistibly suggested. But in spite of this grave difficulty, I ask whether there is of necessity any drop whatever from the plane of Kepler, who realized the laws, to that of Tycho, who never reached any suspicion of the true laws, but had, nevertheless, such faith in their existence that he cheerfully devoted his life to labors of which he never reaped the fruits? Is it not a dangerous doctrine that the work done previous to the formulation of a law is in any way inferior? Take the case of a man like Stephen Groombridge, who made thousands of accurate observations of stars in the early part of last century. Fifty years later something of the value of his work began to emerge from a comparison with later observations which showed what stars had moved and how; but it was not until nearly a century had elapsed that something about the laws of stellar movement was extracted from his patient work, combined with a repetition of similar works at Greenwich. *Then*, with the skilful assistance of Mr. Dyson and Mr. Eddington, Groombridge at last came into the fruits of his labors; but had he been asked during his lifetime for credentials in the shape of laws, on pain of being classed as an inferior in the social scientific scale, he would have been lamentably unprepared. Or consider the case of M. Teisserenc de Bort, when he began sending up his balloons. "Show me your laws," cries the mathematician. "But they are just what I hope to find," replies M. de Bort. "Yes, but surely you have formulated some law you wish to test?" pursues the invigilator. "How am I to give you proper scientific rank unless you can produce at least a tentative law?" "On the other hand, I wish to keep a perfectly open mind," maintains M. de Bort. "Then I fear I can not admit you to our class at present; you must join the infants' class, and I can only give you my best wishes that you may reach maturity some day." Unperturbed, M. de Bort continues to send up his balloons, and almost immediately discovers the great fact about the isothermal region which will be a permanent factor in the meteorology of the future. The mathematician is now ready to admit him, as a worthy person who has found a law about the constitution of the atmosphere. But was not the merit in sending up the balloons whatever came of it? Is it not sometimes more courageous to take risks of failure? The mathematician, safe in his stronghold which possesses "probably in the highest degree attainable by the human intellect the characteristics of perfect and necessary science" is like a man who has inherited a good old-established business, and he has a distaste for the methods of those who have to try new ventures. No doubt many who make such trials fail; but, on the other hand, great fortunes have been made in that way.

It may seem, however, that too much is being deduced from a single quoted opinion, which may easily have been personal and not representative. Let me, therefore, take another which presents a different aspect of the same matter. I take the opening words of Sir G. H. Darwin's address to this section at Birmingham in 1886.

A mere catalogue of facts, however well arranged, has never led to any important scientific generalization. For in any subjects the facts are so numerous and many-sided that they only lead

us to a conclusion when they are marshaled by the light of some leading idea. A theory is then a necessity for the advance of science, and we may regard it as the branch of a living tree, of which facts are the nourishment.

Those who have read the letters of Charles Darwin will recognize that this opinion was also held by the father, and may have been adopted by the son. It is no part of my purpose to raise any question of originality: I mention the point merely to take the opportunity it gives me of showing that I do not approach lightly an opinion held by two such men. With the utmost respect I wish to question whether the criterion indicated goes deep enough. Often have we had ocular demonstration of the value of a theory in stimulating the advance of science, but is advance wholly dependent on the existence of a theory? I have tried to indicate already a deeper motive power by such instances as the work of Tycho, who had no theory, but who perceived the need of observation. And I will now definitely formulate the view that the perception of the need for observations, the faith that something will come of them, and the skill and energy to act on that faith—that these qualities, all of which are possessed by any observer worthy the name, have at least as much to do with the advance of science as the formulation of a theory, even of a correct theory. The work of the observer is often forgotten—it lies at the root of the plant; it is easier to notice the theories which blossom and ultimately produce the fruit. But without the patient work of the observer underground there would be neither blossom nor fruit. It is also easy to fix attention on the mechanical nature of much observation; but this is not the principal feature of observing any more than is numerical computation of mathematics. There are men like Adams who perform gigantic numerical computations faultlessly, but there are others who would take equal rank as mathematicians who can not do three additions correctly; and again others who could compute well and quickly but prefer to hand over that part of their work to some one else. Similarly some great observers themselves look through the telescope, and some merely direct others how to do so; the spark of divine fire is not dependent on this detail, but on the possession of the qualities above mentioned—perception, faith, skill and energy.

By way of bringing out more fully the nature of the assertion made by Sir George Darwin, let me beg your attention to a striking incident in recent astronomical history. We all know how the great astronomer we lost last year, Sir William Huggins (one of those already mentioned as having occupied the presidential chair of the association without having filled that of Section A), initiated the determination of velocities of the heavenly bodies in the line of sight by means of the spectroscope. We know further how the accuracy of these determinations was improved by the application of photography, so that it has recently become possible to measure the velocity of the earth in its orbit (as it alternately approaches and recedes from a given star) with a precision which matches that of other known methods. Now Mr. W. W. Campbell, on his appointment as director of the Lick Observatory in 1900, perceived the desirability of observing the line of sight velocities of as many stars as possible, believed that that outcome would be in some way for the advancement of science, and resolutely acted on that belief, so that for many years the resources of his great establishment have been devoted to this work. He has not turned aside from it even to publish provisional results, and has thereby incurred some adverse criticism.

But, having now accumulated a large mass of observation, he is proceeding to let them tell their own tale, and a wonderful story it is. We have, unfortunately, not time to listen to more than a fraction of it at the moment; but that fraction is well worthy of our attention. When the stars are grouped in classes according to their spectral type, their average velocities differ; and if the spectral types are arranged in that particular order which for quite independent reasons we believe to be that of development of the stars, there is a steady increase in the velocities. To put the matter in a nutshell, the older a star is the quicker it moves. There are, no doubt, several assumptions made in reducing the matter to this simple statement, but I venture to think that they do not affect the point I now wish to make, which is as follows. There is no doubt whatever that the catalogue of facts accumulated by Mr. Campbell, when arranged in an obvious order, has led to a most important scientific generalization—a direct negative at this date of Sir George Darwin's opening sentence, however true it may have been when he wrote it. If we read on, his next sentence doubtless entitles him to say that it was the marshaling of the facts which led to the conclusion. It is not altogether clear to me in what way this marshaling differs from the permitted "arrangement" of the catalogue; but the third sentence seems to imply that the distinction lies in the existence of a theory. But certainly Mr. Campbell had no theory; so far is he from having had a theory that he finds it extremely difficult, if not at present actually impossible, to formulate one, which will satisfactorily account for the extraordinary fact brought to light by the simple arrangement of his catalogue.

Witness his words in Lick Observatory "Bulletin," No. 196, dated April 20 last:

> The correct interpretation of the observed facts referred to in this "Bulletin" seems not easy of accomplishment, and the brief comments which follow make no pretensions to the status of a solution.
>
> That stellar velocities should be functions of spectral types is one of the surprising results of recent studies in stellar motions, for we naturally think of all matter as equally old gravitationally. Why should not the materials composing a nebula or a Class B star have been acted upon as long and as effectively as the materials in a Class M star? . . . The established fact of increasing stellar velocities with increasing ages suggests the questions: Are stellar materials in the ante-stellar state subject to Newton's law of gravitation? Do these materials exist in forms so finely divided that repulsion under radiation pressure more or less closely balances gravitational attraction? Does gravity become effective only after the processes of combination are well under way?

Mr. Campbell is far from being helpless in the situation he has created; he is ready with suggestions, though he modestly puts them as questions; but they are obviously consequent, and not antecedent, to the advance which he has made. Even if the like has never happened before, *this* scientific advance is at any rate due to little more than the accumulation of facts which arranged themselves, as Bacon hoped would naturally happen. But does it detract from the merits of this fine piece of observational work that it was suggested by no leading theory? And I will ask even further: Would its merits have been less if no such immediate induction had presented itself? To this second question I can scarcely expect a general answer in the affirmative; it is so natural to judge by results, and so difficult to look beyond them to the merits of the work itself that I shall not easily carry others with me in claiming that the merits of the observer shall be assessed independently of his results. And yet I affirm unhesitatingly that until this attitude is reached we can not do justice to the observer. I believe it will be reached

in the future, and I shall endeavor to give reasons for this forecast; but I admit frankly that our habit of judging by results will be hard to break. It extends even to the observer himself, and leads to the withholding of his observations from publication, so that he may himself extract the results from them. In the pure interests of the advance of knowledge, it would be far better to publish the material, so that many brains rather than one might work upon it. But the observer knows that by this course he risks losing almost the whole value of his patient work, which would pass as unearned increment to the particular person who was lucky enough to make the induction. Hence arise quarrels such as those between Flamsteed and Newton; the former refusing to publish his observations until he had himself had an opportunity of discussing them, while Newton and Halley exerted their powerful influence in the contrary sense. This situation by no means belongs to a bygone age; it may and does arise to-day, and will continue to arise so long as the recognition of the observer's work is inadequate. It was mentioned a few minutes ago that Mr. Campbell had incurred adverse criticism by accumulating a considerable mass of unpublished observations. Let me be careful not to suggest that his primary motive was the desire to have the first use of them, for I happen to know that there was at least one other good and sufficient reason for his action in the difficulty of finding funds for publication, a difficulty with which observers are only too familiar. But whatever the reason, there were those who regretted the delay in publication as hindering the advance of science. The whole question is a delicate one, and might have been better left unraised at the moment but for a most curious sequel, which puts clearly in evidence the importance of the observer and the desirability of allowing him to discuss his own work. To make this clear a small digression is necessary.

During the last half-dozen years astronomers have been startled on several occasions by pieces of news of a particular kind, indicating the association of large, widely scattered groups of stars in a common movement. The discussion of these movements is to occupy the special attention of this section at one of our meetings, which is an additional reason for brevity in the present allusion. Possibly also most members of the section have already heard of Professor Kapteyn's division of the great mass of bright stars into two distinct groups flying one through the other; and again of the discovery by Professor Boss of a special cluster of stars in the constellation Taurus, moving in parallel lines like a flock of migrating birds. The fascination of this latter discovery, and of one or two others like it, is that when the information supplied by the spectroscope is combined with that furnished by the long watching of patient observers, we can determine the distance of the cluster and its shape and dimensions. We realize, for instance, that there is a large flat cluster migrating just over our heads, so that one member of it (Sirius) is close to our sun—that is to say, only three or four light-years from him. "Close" is a relative term; and the distance traveled by light in three years is from some standpoints by no means despicable. But it is small in comparison with the dimensions of the cluster, which is about one hundred light-years from end to end. The study of these clusters will doubtless occupy our close attention in the immediate future; and it is very natural than the discovery of one should lead to the search for others. Accordingly, we heard last autumn with the deepest interest, but with modified surprise, the an-

nouncement of common movement in a class of stars of a particular spectral type. The announcement rested to some extent on the work done at the Lick Observatory, much of which has been published in an abbreviated form. But Mr. Campbell, in the Lick Observatory "Bulletin" already quoted, gives reasons why he can not accept the conclusion, which is vitiated, in his opinion, by the existence of a systematic error in the observations. Now on such a point as this the observer himself is at any rate entitled to a hearing, and is often the best judge. To take proper precautions against systematic errors is the business of the observer, and his efficiency may very well be estimated by his success in this direction—this would be a far safer guide than to judge by results. But sometimes such errors, which are very elusive, do not suggest themselves until the observations have been completed, and must be detected from the observations themselves. This, again, is rightly the business of the observer, and the desire to free his observations from such error is a perfectly sound and scientific reason for withholding publication. In the present instance the error is a peculiarly insidious one; and, indeed, we are not even certain that it is an error. It is a possible alternative interpretation of the facts that the stars with Class B spectrum are in general moving outwards from the sun, and the additional fact that there is a comparatively large volume of space round the sun at present empty of B stars would seem to favor this alternative. But, as already mentioned, the observer himself prefers rather to credit his observations with systematic error which gives a spurious velocity of 5 km. per second to stars of this type. Now it will readily be understood how an error of this kind may appear doubled: two vehicles traveling in opposite directions approach or recede from one another with double the speed of either; and if one were erroneously supposed to be at rest, the other would be judged to travel twice as fast. In this way the B stars in a particular portion of the sky were judged to be traveling with a common motion of 10 km. per second, which would have been a discovery of far-reaching importance if true, but which the observer relegates to the category of systematic errors.

The illustration will suffice to remind us that the work of the observer is far from being merely mechanical: it demands also skill and judgment—skill in defeating systematic error, and a fine judgment, born of experience, of the success attained. All this is independent of the generalizations which may or may not be arrived at. Bradley's skill as an observer enabled him to discover the aberration of light and the nutation of the earth's axis; it was enhanced rather than lessened when he went on to make further observations which, had he lived, would have conducted him to the discovery of the variation of latitude. After his death the world waited more than a century for this discovery to be made, but Mr. Chandler, who played a leading part in it, has declared that Bradley was almost certainly on its track. It would almost seem that an observer is only properly appreciated by another observer. There are doubtless many who, assisted by the knowledge that Bradley's skill had twice previously conducted him to a discovery, would be ready to admit the value of his later work, although he did not live to crown it; but how many of these could properly appreciate Bradley without such assistance?

I venture to think that the great brilliance of Newton has dazzled our vision so that we do not see some things quite clearly.

> Had it not been for Newton [writes De Morgan in his "Budget of Paradoxes," p. 56] the whole dynasty of Greenwich astronomers, from Flamsteed of happy memory, to Airy, whom Heaven preserve, might have worked away at nightly observation and daily reduction without any remarkable result: looking forward, as to a millennium, to the time when any man of moderate intelligence was to see the whole explanation. What are large collections of facts for? To make theories *from*, says Bacon; to try ready-made theories *by*, says the history of discovery; it's all the same, says the idolater; nonsense, say we!

But nothing of this will fit in with what we know of Bradley's work; he discovered aberration, not by any help from Newton, but by accumulating a mass of observations. He had no ready-made hypothesis, or rather he had a wrong one, viz., that the stars would show displacement due to parallax; and after this was proved wrong, as it was at the very outset, he had nothing in the way of a theory to guide him, and found great difficulty in devising one *after* he had collected his facts, which spoke for themselves so far as to reveal plainly the essential features of the phenomenon in question.

> Modern discoveries (on the preceding page of the "B. of P.") have not been made by large collections of facts, with subsequent discussion, separation, and resulting deduction of a truth thus rendered perceptible.

To this I venture to oppose not only such work as that of Bradley, but much in the recent history of astronomy; the discoveries about systematic proper motions, about moving clusters, about the growth of velocity with life history, and so forth.

> There is an attempt at induction going on, which has yielded little or no fruit, the observations made in the meteorological observatories. The attempt is carried on in a manner which would have caused Bacon to dance for joy. . . . And what has come of it? Nothing, says M. Biot, and nothing will ever come of it: the veteran mathematician and experimental philosopher declares, as does Mr. Ellis, that no single branch of science has ever been fruitfully explored in this way.

De Morgan was a mathematician, and I have noticed that mathematicians are apt to be crisp in their statements: but he is a bold man who says "nothing will ever come of it." Perhaps an equally crisp statement on the other side may be pardoned. I adventure the remark that if nothing has hitherto come of such observations, it is because observers have been misled by the very teaching of De Morgan and others who share his views: they have been told that they will do no good without a theory until they have come to believe it; whereas the truth probably lies in a quite different direction. To present my reasons for this proposition I must ask you first to consider in some detail the method of discussing meteorological observations suggested some years ago by Professor Schuster. He gave an account of it to the Department of Cosmical Physics, over which he presided in 1902, so that I must face some repetition of what he said; but the matter is so important that I trust this may be pardoned.

Let us compare the records produced on a gramophone disk by the playing of a single instrument and by that of an orchestra. The first will be comparatively simple, and when suitably magnified will show a series of waves which in certain parts of the record form sequences of great regularity. These represent occasions when the single instrument played a long-sustained note, the pitch of which is indicated by the frequency of the wave. If the instrument plays more loudly, while still keeping to the same note, the heights of the waves will increase, though their frequency will not be altered. The exact shape of each wave will represent the quality of tone which characterizes the instrument: and if another instrument were to

play the same note it would be different. But so long as we keep to the same instrument, whenever the same note recurred we should find, generally speaking, the same shape of wave: and we could resolve it into its constituents, one being the main wave and others harmonics of different intensities. The analysis of such a record would thus be a comparatively simple matter, on which we need scarcely dwell further. Very different is the case of the orchestral record. There are numerous instruments, playing notes of different pitch, intensity and character, each of which, if playing alone, would produce its own peculiar record. But when they play together the records are all combined into one. The needle can only make one record, but it is a true sum of all the individuals; for when the instrument is set to reproduce the playing of the orchestra, a trained ear can perceive the playing of the separate instruments—when the strings are playing alone, and when the wind joins them: when the horn comes in and whether there are two players or only one: nay, even that one of the second violins is playing somewhat flat! This could not happen unless the individual performances were essentially and truly existent in the combined record; and yet this consists of only one single wavy line. The waves are, however, now of great complexity, and it seems at first sight hopeless to analyze them. The mathematician knows, however, that such analysis is possible, and is quite simple in conception, though it may be laborious in execution. Selecting a note of any given pitch, a simple calculation devised by Fourier will reveal when and how loudly that particular note was being played. This being so, it is only necessary to repeat the process for notes of different pitch. But though this can be stated so simply, the carrying out in practise may involve immense labor, by reason of the number of separate notes to be investigated. It is not merely that these will extend from low growls by the double bass to high squeaks by the fiddles, but that their variety within these wide limits will be so great. The series is really infinite. We might indeed prescribe a certain scale of finite intervals for the main notes, as in a piano: but the harmonics of the main tones would refuse to obey this artificial arrangement and would form intermediate pitches which must be properly investigated if our analysis is to be complete. Moreover the orchestral instruments will not keep to any such prescribed intervals, but will insist on departing from them more or less, according to the skill of the performer. There is a story told of an accompanist who vainly tried to adjust the key of his accompaniment to the erratic voice of a singer. At length in exasperation he addressed him as follows: "Sir, I have tried you on the white notes, and I have tried you on the black notes, and I have tried you on white and black mixed: you are singing on the cracks!" Some instruments will almost certainly "sing on the cracks" so that we shall not easily escape from the examination of a very large number of possibilities indeed—we may well call them *all* the possibilities within the limits of audibility. The illustration is already sufficiently developed for provisional use. My suggestion is that science has only dealt so far with the easy records and that the genuine hard work is to come. If we can imagine a number of deaf persons turned loose among a miscellaneous collection of gramophone records, with instructions to make what they could of them, we can readily imagine that they would pick out those of single instruments first. We must make the researchers deaf so that they may not use the beautiful mechanism of the human ear which has as

yet no analogue in scientific work. Possibly something corresponding to this wonderful and still mysterious mechanism may ultimately be devised, and then the course of scientific research may be fundamentally altered: but for the present we must regard ourselves as deaf, and as condemned to work by patient analysis of the records. It is perfectly natural, and even desirable, to begin with the easy ones, and the finding of an easy one would no doubt in our hypothetical case be a sensational event, reflecting credit on the lucky discoverer, who would be hailed as having detected a new law, *i. e.*, a new simple case. But sooner or later these will be used up and we must attack the more complex orchestral records in earnest. Shall we find that the best music is still to come, as our illustration suggests?

But we must return to Professor Schuster's suggested plan of work. It is closely similar to that already sketched for dealing with a complex gramophone record. Let us consider the record of any meteorological element such as temperature or rainfall. When these records are put in the form of a diagram in the familiar way we get a wavy line, which has much in common with that traced by a gramophone needle on a smaller scale. The sight of the complexities is almost paralyzing, especially when those who would otherwise attack the problem are deterred by the emphatic assertion that it is useless to do so without the equipment of some guiding hypothesis. Most of the obvious hypotheses have of course already been tried, and the majority of them have failed. It is to Professor Schuster that we owe the vitally important advice to disregard hypotheses and make a complete analysis of the record. Of course the labor is great, but the genuine observer is not afraid of labor: he has a right to ask, of course, that it shall not be interminable: and when we are told that we must examine an almost infinite series of possibilities there would seem to be some danger of this. But in practise the work always resolves itself into a series of finite steps, owing to the finite extent of the observations. A definite illustration will make this clear. Suppose we have ninety years of rainfall and we test the record for a frequency of nine years, which would run through its period ten times: we must certainly test independently for a frequency of ten years, which would only run through its period nine times, and thus lose one whole period on the former wave: and so also for a possible frequency of nine years and a half, and of nine years and a quarter. But a frequency of nine years and one day would not be distinguishable from that of nine years, for the phase would only change 1° in the whole available period of observation. Indeed the same might be said of all frequencies between nine years and nine years and one month: for the extreme difference of phase would not exceed 40°. But in course of time when the series of ninety years' observations become 900 years, the differences of phase will approach or exceed a complete cycle, and we must accordingly narrow the intervals between frequencies chosen for examination.

The length of the series of observations is thus an important factor in our procedure, for which Professor Schuster has indicated a beautiful analogy. Our illustrations hitherto have been provided by the science of sound, but we may also gather them from that of optics. Testing a series of rainfall observations for a periodicity is like examining a source of light for a definite bright line. The process of computation indicated by Fourier gives us what corresponds to the measured brilliance of the bright line; and the complete process

of analysis corresponds to the determination of the complete spectrum of the source of light, which may consist of bright lines superimposed on a continuous spectrum. And the length of the series of observations corresponds simply to the resolving power of the optical apparatus. The only point in which the analogy breaks down is unfortunately that of ease and simplicity. In the optical analogy, an optical instrument performs for us with completeness and despatch the analysis, which in its counterpart must be performed by ourselves with much numerical labor.

Let us consider how we should most conveniently proceed to the complete delineation of a spectrum. We should ultimately need an apparatus of the greatest possible resolving power, but it might not be advisable to begin with it: on the contrary, a small instrument which enabled us to glance through the whole spectrum might save much time. Suppose, for instance, that there was a bright line in the yellow; our small instrument might suffice to show us that it was due either to sodium or helium, but no more: the decision between these alternatives must be reserved for the larger instrument. On the other hand, if no line is seen in the yellow at all, we have ruled out both possibilities at once, and so economized labor. Hence it is natural to use first an instrument of low resolving power and afterwards one of higher.

Now in the work for which this serves as an analogy this procedure is actually imposed upon us by the march of events. It has been pointed out that the resolving power of the optical apparatus corresponds exactly to the length of our series of observations. Hence our resolving power is continually increasing. Quite naturally we begin with a short series of observations, which shows us our lines blurred and confused: to define and resolve them we have but one resource—"wait and see"; wait and accumulate more observations, to lengthen the series. But the lengthening must be in geometrical progression: we must double our series to increase the resolving power in a definite ratio; and double it again. We begin to get a glimpse of the important part to be played by the observer in the future, and of his increase in numbers.

Let us glance at a few illustrations of the use of this method. Professor Schuster has applied it, for instance, to the observations of sunspots. Now it may fairly be said that the general law of sunspots was thought to be known: the variation in a cycle of about $11\frac{1}{8}$ years has long been considered to represent the facts: it catches the eye at once in a diagram, and though there are also obvious anomalies, they had not been deemed worthy of any particular attention (with one exception presently to be mentioned), until Professor Schuster undertook his analysis. To his surprise, when he calculated the periodogram of sunspots, he found two entirely new facts: (1) that there were other distinct periodicities, notably of about four, eight and fourteen years; (2) that the eleven-year cycle had not been continuously in action, but that during the eighteenth century it had been much less marked than the eight-year and fourteen-year cycles.

A further most interesting fact seems to emerge, viz.: that several of the periodicities are harmonics of a major period of some thirty-three years or more, and it seems just possible that a connection may ultimately be established with the Leonid meteor-swarm, which revolves in this period. But it would take us too far from our main point to follow these most interesting corollaries: the point well worthy of our special attention is this, that we have here an undoubted advance in knowledge

resulting, not from observations made with regard to any particular theory, but from the simple collection of facts and the arrangement of them in all possible ways, the very method which has been despised and condemned. Let us contrast with this the method hitherto adopted, which has been to hunt for some particular possible cause which will give the eleven-year period. Thus Professor E. W. Brown suggested[2] in 1900 that the eleven-year cycle was due to the tidal action of Jupiter, altered periodically by two causes:

	Period	Mag. of Force
By Jupiter's eccentricity .	11.86 years	0.33
By the motion of Saturn .	9.93 years	0.11

and he suggests his contention by an ingenious and striking diagram, which seems to explain not only the main cycle, but its anomalies. (This paper is, in fact, the exception above referred to.) But if his contention is correct the periodogram should show bright lines at 11.86 and 9.93 years, which it does not. This is worth noting, since it is sometimes said that there is nothing new in Professor Schuster's method, which is true enough in one sense, since it is simply the analysis of Fourier. The novelty consists (1) in calling attention to the necessity of applying the analysis in all cases, a necessity which I venture to think was overlooked in this instance by so able a mathematician as Professor Brown; and (2) in the insistence on the examination of *all* periods, irrespective of any particular theory or preconception. And in this second character the method seems to me to cut at the root of the canons of procedure which have found favor hitherto.

As a second instance I present with much more diffidence a few results which seem to emerge from a very laborious analysis of the rainfall at three or four stations, for which Professor Schuster and myself are jointly responsible. There is some evidence for a cycle of 600 days in the Greenwich rainfall to which a further cycle in the quarter period (150 days) lends support. On analyzing the Padua records it is found that these cycles do not exist, but it seems quite possible that there are cycles of rather shorter period, viz., 594 days and 148½ days: the relation of four to one being maintained. The separate links in this chain are none of them very strong, but they seem to hang together, and there is certainly a case for further investigation. But would this case have been likely to present itself in any other way than by the examination of the whole periodogram? I find it very difficult to think, even now the periods are suggested, of any theoretical cause: to let the facts speak for themselves took much time and labor, but I venture to think that we might have waited far longer, and cudgeled our brains much more, before we got the clue by formulating hypotheses of causation.

[2] *Monthly Notices R. A. S.*, LX., p. 600.

A new method is not adopted widely all at once. Professor Whittaker has, I am glad to say, begun to apply the method to variable star observations, and is already hopeful of having obtained valuable information in the case of the star *SS Cygni*. Possibly we may hear something from him at this meeting. Meanwhile I take the opportunity to remark that the history of variable star observation affords us many lessons as to the desirability of simply accumulating observations and letting them speak for themselves instead of being guided by a theory on hypothesis. Let me give an instance. One of the fathers of variable star-observing, the late N. R. Pogson, made a series of excellent observations of the star *R Ursæ Majoris* in the years 1853 to 1860. He then seems to have

formulated a particularly unfortunate hypothesis, viz., that he knew all about the variation; and he accordingly only made sporadic observations in succeeding years. Now this star, along with many others, varies in a manner which may be illustrated from the occurrence of sunrise. The average interval between two sunrises is exactly twenty-four hours: but this is only the average. In March the sun is rising two minutes earlier every day, and the interval is therefore two minutes short of twenty-four hours; as the year advances the daily gain slackens, and at midsummer the interval is exactly twenty-four hours: then the sun begins to rise *later* each day, and the interval exceeds twenty-four hours and so on: so that there is a regular yearly swing backwards and forwards through a mean value: and as in the case of all such swings there is a sensible halt at the extreme values. Now when Pogson made his observations of *R Ursæ Majoris* in 1853–60 it was time of halt at an extreme: the period remained stationary and the variation repeated itself eleven times in closely similar fashion, so that Pogson concluded it would continue in the same way. How many instances suffice for an induction? Many inductions have been based on fewer than eleven. Unfortunately the period was just beginning to change sensibly, and we lost much valuable information, for no one else repaired Pogson's neglect adequately: and the whole swing of period occupies about forty years, so that the opportunity of studying the changes he missed has only quite recently returned. We are thus reminded how disastrous may be a break in the record. It should be one of the articles of faith with an observer that the record is sacred and must not be broken. Most of them indeed act on that principle already, but there are heretics, and it pained us to find even Professor Schuster himself tinged with heresy. On the very occasion when he did so much for the observer by presenting his beautiful method, he suggested that it might even be advisable to drop observing for a time in order to apply the method to accumulated observations. He may possibly be right, but the observer had better believe him wrong. There ought to be an "observer's promise" like the promise of the boy scout; and one part of it should be not to interrupt the record, and another should be to publish the observations regularly, and never to let them accumulate beyond five years.

The method of Professor Schuster is not the only one that has been recently proposed for dealing with large masses of observations. We have also the methods of Professor Karl Pearson. These have been far more widely adopted for use than the periodogram, and they have also been more adversely criticized. As regards criticism, I think it is fair to say that it has chiefly been directed towards the nature of the material on which Professor Pearson has used his process than on the process itself, and at present we need not be concerned with it. The processes themselves are sound enough; one of them, for instance, is much the same as the old method of least squares in a simple form. But if the same criticism is made as has been made on the method of the periodogram—viz., that it is not new, we can reply in almost the same words in the two cases: the mathematical calculus may not be new, the novelty is the insistence on the application of it, and the application to all possible cases. Professor Pearson ceases to look for one principal factor only, and examines all possible factors, just as Professor Schuster examines all possible frequencies. Let us recur for a moment to the words of Sir George Darwin previously quoted.

A mere catalogue of facts, however well arranged, has never led to any important scientific generalization. For in any subject the facts are so numerous and many-sided that they only lead us to a conclusion when they are marshaled by the light of some leading idea.

Let us take, for instance, a catalogue of variable stars such as those of Mr. Chandler. Particulars for each star are given in separate columns, exclusive of the name and number. We might wait long for a leading idea to guide us in marshaling the facts, and so far as I know we have waited till now without any such idea occurring to any one. But Professor Pearson insists on the plain duty of determining the correlation between each and every pair of these columns, and any others we may be able to add. Anybody could have made the suggestion, and there was plenty of elementary mathematical machinery in existence for carrying it out; but so far as I know nobody did, any more than the critics of Columbus suggested how to stand up an egg. But the suggestion having been made by Professor Pearson, it was so clearly sound that I did what lay in my power to follow it up: with the result that certain correlations were at once indicated which at least pave the way for further inquiry. If we can not say more than this it is simply because the catalogue of facts was not large enough. So far from the observers having wasted their energies by observing without any theory to guide them, more work of the same kind would have been welcome, for it would have reduced the probable error of the correlations indicated. As an example I may quote the following. It has already been mentioned that a variable-star maximum though it may recur after a more or less definite period on the average, is subject to a swing to and fro like the time of sunrise. Let us call the average interval *the day* of the star and the period of swing *the year,* without implying anything more by these names than appears in the analogy. Then I found[3] that the day and the year were correlated, the value of the coefficient being

$$r = 0.56 \pm 0.08.$$

Having obtained this clue, it was interesting to use it for the elucidation of individual problems. The *days* of many stars are by this time pretty well known, but their *years* are very uncertain. In nine or ten cases the assessment of the vaguely known *year* was under revision, and in all, without exception, the revised assessment tended in the direction of the formula. In one case (*S Serpentis*) the formula suggested the solution of a long-standing puzzle.[4] Finally the inquiry is suggested whether our own sun may be treated as a variable star with a period or *day* of eleven years, in which case its time of swing a *year* should be about seventy-five years, if the formula is strictly linear. There are found to be indications of a swing of this order of magnitude, though the time given by the periodogram method is fifty-four years.[5] If the relation between *year* and *day* is not strictly linear these figures could easily be reconciled for a case lying so far outside the limits within which the formula was deduced. But the ultimate successful establishment of the connection is of less importance for our present purpose than to notice the fruitfulness of the method of suggestion, which is as mechanical as Bacon himself could have wished.

Let us admit frankly that there is an appearance of brutality about such methods. Is our method of search to be merely the old and prosaic one of leaving no stone unturned? We have been led to believe that there should be more of inspiration in it;

[3] *Monthly Notices R. A. S.*, LXVIII., p. 544.

[4] *Monthly Notices R. A. S.*, LXVIII., p. 561.

[5] *Ibid.*, p. 659.

that a true man of science should have some of the qualities of that fascinating hero of fiction, Mr. Sherlock Holmes, who picks up his clue and follows it unerringly to the triumphant conclusion. Such qualities will do the man of science no possible harm: indeed they will be of the utmost value to him. The point to which I am now calling attention is the change in nature of the opportunities for using them, which are becoming every day more confused. Dr. Conan Doyle, in the exercise of his art, keeps our attention fixed on a single trail: he conceals from us by mere omission the numerous trails which cross it. We admire the skill of the Indian who pursues an enemy through the trackless forest: but his success depends on the simplicity brought by this very tracklessness, and would be imperilled if there were numerous tracks. It may be remarked, however, that there is a still higher sagacity—that of the hound who even among a number of tracks can pick out the right one by scent. Let us imagine for a moment that the scientific man can be endowed in the future, by training or by some new invention, with a faculty of this kind, so that he may unerringly pursue a single trail even when it is crossed and recrossed by others. Then in the terms of this metaphor I draw attention to the fact that he has still to determine which is the right trail; and that in general he can only do so by pursuing each in turn to the end. To take an example from a recent scientific anecdote: I relate the story as I was told it, and even if incorrect in detail it will serve its purpose as a parable. The Röntgen rays were discovered originally by their photographic action, but afterwards it was found that they would render a screen of calcium tungstate phosphorescent. I was told that this discovery had been made in this wise: Mr. Edison had a large collection of different chemicals, and a number of assistants: he set his assistants busily to work to try each substance in turn until the right one was found. Now this is not only a genuine scientific process, but it is *the fundamental process*. Let it be frankly admitted that our instincts are against it. We should much prefer to hear that some *hypothesis* had pointed the way, even a false hypothesis such as actually led to the discovery of the possibility of achromatism in lenses. Or if *memory* had played a part: The other day Professor Fowler identified the spectrum of a comet's tail with one taken in his laboratory, of which he had some recollection, and our human sympathies fasten at once on this idea of recollection as a praiseworthy element in the discovery. Nay, even mere *accident* appeals to us more than brutal industry: if Mr. Edison had wandered into his laboratory, picked up a bottle at random, and found it answer his purpose, I venture to say that we should have instinctively awarded him more merit: there would have been just a chance that he was inspired. Let us by all means welcome hypothesis, memory, inspiration and accident whenever and wherever they will help us: but they may fail, and then our only resource is to help ourselves by the unfailing method of examining all possibilities. The aid of the others is adventitious and comes, like that of the gods, most readily to those who help themselves.

The maxim of "leaving no stone unturned" was enunciated from a rather different point of view some dozen years ago by an American geologist, Professor T. C. Chamberlin, of Chicago, in a short paper for students entitled "The Method of Multiple Working Hypotheses."[6] After recalling how much the march of science in early days was retarded by the tyranny

[6] University of Chicago Press, 1897.

of a theory formulated too hastily, and how in later times attempts have been made to remedy this evil by holding the theory, provisionally only, as a working hypothesis, Professor Chamberlin points out that even the working hypothesis has serious disadvantages:

> Instinctively there is a special searching-out of phenomena that support it, for the mind is led by its desires. . . . From an unduly favored child it readily grows to be a master and leads its author whithersoever it will. . . . Unless the theory happens perchance to be the true one, all hope of the best results is gone. To be sure, truth may be brought forth by an investigator dominated by a false ruling idea. His very errors may indeed stimulate investigation on the part of others. But the condition is scarcely the less unfortunate.
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> To avoid this grave danger the method of multiple working hypotheses is urged. It differs from the simple working hypothesis in that it distributes the effort and divides the affections. . . . In developing the multiple hypotheses, the effort is to bring up into view every rational explanation of the phenomenon in hand and to develop every tenable hypothesis as to its nature, cause or origin, and to give all of these as impartially as possible a working form and a due place in the investigation. The investigator thus becomes the parent of a family of hypotheses: and by his parental relations to all is morally forbidden to fasten his affections unduly upon any one. In the very nature of the case, the chief danger that springs from affection is counteracted.

For the further elucidation of Professor Chamberlin's proposals I must refer my audience to his original paper, which is well worthy of careful attention. He does not shirk consideration of the drawbacks —"No good thing is without its drawbacks," he writes. And it may be added that no good thing is entirely new, or entirely old. Perhaps it is better to say that it is generally both new and old. The method of multiple hypotheses is new because it is still necessary to remind scientific workers of all kinds that so long as they restrict themselves to the examination of one hypothesis only they can never reach complete logical proof: they can only attain a high measure of probability. What is often called verification[7] is not complete proof, but only increase in probability: for complete proof it is necessary to show that no other hypothesis will suit the facts equally well, and thus we are bound to consider other possible hypotheses even in the direct establishment of one.

But the method is also old in that it has long been adopted in practise, however partially and unconsciously by scientific workers of all kinds. When as a boy at school I began to make physical measurements under Mr. J. G. McGregor (now professor of physics at Edinburgh) I learned from him one golden rule: "Reverse everything that can be reversed." The crisp form of the rule may be new to many who have long used it in their work: and its use is simply that of "multiple hypotheses." For when the current in a wire is reversed, the hypothesis is tacitly

[7] To show that the facts agree with the consequences of our hypothesis is not to prove it true. To show that is often called *verification:* and to mistake verification for proof is to commit the fallacy of the consequent, the fallacy of thinking that because, if the hypothesis were true, certain facts would follow, therefore, since those facts are found, the hypothesis is true. . . . A theory whose consequences conflict with the facts can not be true; but so long as there may be more than one giving the same consequences, the agreement of the facts with one of them furnishes no ground for choosing between it and the others. Nevertheless, in practise we often have to be content with verification; or to take our inability to find any other equally satisfactory theory as equivalent to there being none other. In such matters we must consider what is called the weight of the evidence for a theory which is not rigorously proved. But no one has shown how weight of evidence can be mechanically estimated; the wisest men, and best acquainted with the matter in hand, are oftenest right.—"An Introduction to Logic," by H. W. B. Joseph, fellow and tutor of New College, Oxford, Clarendon Press, 1906, p. 486.

made, the effect observed may be due to the direction of the current: and when a measured spectrum photograph is turned round and remeasured, it is an admission of the hypothesis that the direction of measurement may be partly responsible for the observed displacements of the spectrum lines. By the various reversals we endeavor, in Professor Chamberlin's words, "to bring up into view every rational explanation of the phenomenon in hand" which can be brought up into view in this way. But truly "no good thing is without its drawbacks," and one drawback to the recognition of this principle is that, by a process of mental confusion, it seems sometimes to be regarded as a distinct merit in a piece of apparatus that it can be reversed in a large number of ways. It must be remembered that the hypotheses thus examined and ruled out are chiefly instrumental ones superadded to those of nature: and the latter are already sufficiently numerous, without our ingenious additions.

The view which I have endeavored to put before you of the inevitable course of scientific work is that it will depend more and more on the patient process of "leaving no stone unturned." It may not be an inspiring view, but it should be at least encouraging, for it follows that no good honest work is thrown away. And it is just this encouragement of which the observer, as opposed to the worker in the laboratory and the mathematician, stands sometimes in sore need. The worker in the laboratory can often clear away his hypotheses on the spot: he can reverse his current then and there: but this is often impossible for the observer, who can and does reverse his spectrum plate for measurement, but to reverse the motion of the earth which affected the lines must wait six months: and to reverse also the motion of the star may have to wait six years, or sixty, or sixty thousand. In many cases he must leave the reversal to others, and thus not only can he not test all his hypotheses, but he may not even be able to formulate them. His aim can not, therefore, be to establish within his lifetime some new law, and his work is not, therefore, to be appreciated or condemned by his success or failure in this respect. There are truer aims and surer methods of judgment. Something is inevitably lost when we endeavor to express these aims in the concrete; but for the sake of illustration we may say that the true observer is always endeavoring to reach the next decimal place, and is ever on the alert for some new event. Of the pursuit of the next decimal place it is needless to say more: the aim is as familiar in the laboratory as in the observatory. But I often think that the recognition of new events is scarcely given its proper place in the annals of science, if we have due regard to the consequences. I have protested that in much of his work the observer can not be judged by the fruits of his labor, though there is an instinctive tendency to judge in this way: but here is a case where he might well be content to be so judged, and yet the consistent award is withheld. Think for a moment of the very considerable additions to our knowledge which have accrued from the discovery by Professor W. H. Pickering of an eighth satellite to Saturn. The discovery led directly to the recognition of the retrograde motion; and to explain this we were led to revise completely our views of the past history of the solar system. Incidentally it stimulated the search for other new satellites, resulting in the discovery of a curious pair to Jupiter and next of the extraordinary eighth satellite; while it was the investigation of the orbit of this curiosity which suggested an eminently successful method of work on cometary orbits. If we judge scientific work

by its results we must take into account all this subsequent history in our appreciation of Professor Pickering's achievement. But whether we do so or not is probably a matter of indifference to him, for the true observer is above all things an amateur, using the word in that splendid sense to which Professor Hale recently introduced us. There have been many attempts to define an amateur. One was given by Professor Schuster in his eloquent address to this section at Edinburgh in 1892:

> We may perhaps best define an amateur as one who learns his science as he wants it and when he wants it. I should call Faraday an amateur.

We need not quarrel with his definition and certainly not with the noble instance with which he points it. But after all I prefer the definition of Professor Hale:[8]

> According to my view, the amateur is the man who works in astronomy because he can not help it, because he would rather do such work than anything else in the world, and who therefore cares little for hampering traditions or for difficulties of any kind.

The wholly satisfactory nature of this view is that it provides not only a definition, but an ambition, and a criterion. We feel at once the ambition to become amateurs, for I deny stoutly that the distinction is conferred at birth: it comes with work of the right kind. And we may know what is work of the right kind by this if by nothing else: that by diligently performing it we shall become amateurs who find it impossible to stop: "who work in astronomy because we can not help it." Before an army of such men even the vast hordes of dusky possibilities of which we are beginning to catch glimpses must yield. The fight may seem, and no doubt is, without end; and the opportunities for glorious deeds by which outlying whole troops of the enemy are demolished at once are becoming rarer. We are confronted with the necessity of attacking each possibility singly, which threatens the stopping of the conflict through sheer weariness. Clearly the army of amateurs is the right one for the work: weariness can not touch them: they will go on fighting automatically because "they can not help it."

H. H. Turner

[8] *Monthly Notices R. A. S.*, LXVIII., p. 64.

SAMUEL HUBBARD SCUDDER

Samuel Hubbard Scudder was born at Boston, April 13, 1837, and died at 156 Brattle Street, Cambridge, May 17, 1911, at the age of seventy-four years. He was, perhaps, the greatest American entomologist of his time. Whether we regard the mere mass of his work or its excellence or the breadth of view shown, we who belong to this later generation must stand amazed and humbled. Which of us can even imagine himself girding his loins for such a task as the "Nomenclator Zoologicus" or the great volumes on the "Butterflies of the Eastern United States"? Such things may now be undertaken cooperatively, or with much expert and clerical assistance; but Scudder was both architect and builder of his great works, responsible for everything, very rarely seeking collaboration, except for the purpose of gathering materials. I corresponded actively with him for many years, and have before me a pile of old letters and postal cards in the familiar handwriting. As I look them over I think of two especially prominent characteristics, his *enthusiasm* and his *kindness*. Herein he ranks with another famous entomologist, W. H. Edwards, who at one time wrote me almost daily concerning the progress and welfare of an interesting caterpillar I had sent him. It was not enough for Scudder to discover new facts or perceive new relationships; he must at once communicate them to those likely to be interested; and the charm of his letters, without the reserve natural to the printed page, must have warmed the heart and increased the zeal of many a younger man. May we, who now are obliged in such manner as we can to fill in the vacated ranks,

remember and imitate the splendid courtesy of the fine old men we have known!

I only saw Scudder once after he was stricken with paralysis, and his work was done. This was in 1907, at the time of the Zoological Congress in Boston. I was allowed to talk with him for three minutes only, but in those minutes he enquired after various old friends in the west, and looked at some new fossils from his old-time hunting ground at Florissant. He at once recognized the relationships of the fossil Nemopterid, although he had never seen such a fossil before; and being shown an excellent example of his own genus *Holcorpa,* said "that is a better one than mine." I mention these facts to show that his mind was still active, although he was physically unable to work and mentally incapable of any continuous strain. It is one of the most pathetic facts in the history of science that for seven years this great naturalist remained paralyzed and helpless, with so much of the work he had planned to do still unfinished.

Scudder's life was in many respects peaceful and happy, but he suffered much. Dr. C. J. S. Bethune has recently written the following:[1] "When the writer first came within the charmed circle of which Dr. Scudder was the center, some forty years ago, he and his young wife were living in Cambridge. Not long after, on account of her delicate health, they went to the south of France, and enjoyed for a time the balmy climate of the Riviera; but health was not restored, and soon the much-loved wife was taken away. Years after he experienced another bitter sorrow in the death of his only child, who had entered upon a physician's career with every prospect of attaining distinction in medical science." Scudder's son died of rapid tuberculosis, and I remember well when every letter, mainly about Orthoptera, would contain something about him. This loss came nearly at the end of Scudder's active life, and he never was quite himself again.

I have thought it useful to prepare a very brief chronological summary of Dr. Scudder's life, in order to show in some measure the character and volume of his work.

[1] *Canadian Entomologist,* July, 1911.

1837. Born at Boston, Mass., April 13.

1857. A.B. at Williams College.

1858. Published list of terrestrial Mollusca found at Williamstown, in *Williams Quarterly.* This, his first published paper, appears to be his only one on Mollusca.

1859. Report to Boston Society of Natural History on the collection of insects of T. W. Harris. (First entomological contribution.)

1860. A.M. at Williams College. Index to Entomological Writings of T. W. Harris. (Hagen wrongly dates this 1859.)

1861. First paper on Orthoptera (*Proc. Boston Soc. Nat. Hist.*). North American *Pieris;* the first paper on butterflies.

1862. B.S., Lawrence Scientific School, Harvard University. Assistant to Louis Agassiz at Museum of Comparative Zoology (1862–64). Materials for Monograph of North American Orthoptera (71 pp.). Scudder's famous sketch, "In the Laboratory with Agassiz," was published in *Every Saturday,* 1874, and reprinted many times.

1863. Insect Fauna of White Mountains. List of Butterflies of New England.

1864. Became custodian, Boston Society of Natural History, and held this position until 1870.

1865. First contribution on fossil insects: Devonian [now considered Carboniferous] Insects of New Brunswick.

1866. First discovered fossil neuropterous insects in North America. Dragon-flies from Isle of Pines and White Mountains.

1868. Carboniferous (fossil) insects. Catalogue of Orthoptera of North America. Century of Orthoptera (1868–79).

1869. Edited Entomological Correspondence of T. W. Harris. New Orthoptera from the Andes.

1870. Scudder and Burgess on Genitalia of Nisoniades.

1871. Systematic Revision of some of the American Butterflies.

1872. Fossil Butterfly from France.

1873. Carboniferous (fossil) Myriapods.

1875. General Secretary of the American Association for the Advancement of Science. Historical Sketch of Generic Names proposed for Butterflies. Fossil Butterflies. Orthoptera from Northern Peru.

1876. Synopsis of North American Earwigs. Critical and Historical Notes on Forficulariæ.

1877. Elected to National Academy of Sciences. Tube-constructing Ground Spider from Nantucket.

1878. Rhachura, a new genus of fossil Crustacea (from Coal Measures).

1879. Assistant Librarian at Harvard (to 1882). Catalogue of Scientific Serials of all Countries. George Dimmock published "The Writings of Samuel Hubbard Scudder," enumerating 315 titles.

1882. Nomenclator Zoologicus (1882–84). This is a list of all the generic and family names proposed for animals, and is simply invaluable to the zoologist. Archipolypoda, a subordinal type of spined Myriapods from the Carboniferous.

1883. Editor of SCIENCE (to 1885). He also edited the entomological journal *Psyche* for many years.

1884. Paleozoic Arachnids.

1885. Paleodictyoptera (Paleozoic Hexapoda).

1886. Paleontologist to U. S. Geological Survey (to 1892). Published "Winnepeg Country, or Roughing it with an Eclipse Party," under a pseudonym.

1888. Paleozoic Cockroaches from Ohio.

1889. Butterflies of the Eastern United States and Canada, with special reference to New England (3 volumes). This is, I suppose, the finest work on any butterfly-fauna yet published. It gives a most elaborate account of every species, from all points of view, and is enlivened by dissertations on general subjects connected with entomology. It is also profusely and beautifully illustrated.

1890. Fossil Insects of North America: The Pretertiary Insects. Tertiary Insects of North America. Bibliography of Fossil Insects. Hon. Sc.D. at Williams; LL.D. at Pittsburgh.

1891. Index to the Known Fossil Insects of the World.

1892. The Genus *Hippiscus*.

1893. Brief Guide to the Commoner Butterflies of the Northern United States and Canada. The Life of a Butterfly. Orthoptera of Galapagos Islands. The Tertiary Rhynchophorous Coleoptera of the United States.

1894. Vice-president of the American Association for the Advancement of Science. Tertiary Tipulidæ. North American Ceuthophili.

1895. Canadian Fossil Insects. Revision of American Fossil Cockroaches. Miocene Insect-fauna of Œningen.

1896. Mantidæ of North America. North American Nemobius.

1897. Revision of the Orthopteran Group Melanopli. Guide to the Genera and Classification of the North American Orthoptera.

1898. Alpine Orthoptera of North America.

1899. Revisions of Schistocerca and Myrmecophila.

1900. Adephagous and Clavicorn Coleoptera from Tertiary Deposits at Florissant. Catalogue of Described Orthoptera of the United States and Canada.

1901. Alphabetical Index to North American Orthoptera. (A complete guide to the whole literature of the subject to the end of the nineteenth century.)

1902. The last paper published: Scudder and Cockerell, List of the Orthoptera of New Mexico. Dr. Scudder's last scientific work was correcting the proofs of this paper.

Scudder's Taxonomic Work

Scudder's taxonomic work was characterized by great precision and clearness of statement. Everything was well arranged, and every pertinent fact clearly given. Localities and collectors were faithfully cited, and bibliographic references were exhaustive. It would be well if some of our writers of the present generation would study his methods, simply regarded as models of presentation. For certain of his views, Scudder was frequently attacked, but he did not enter into controversy. More especially, his treatment of the genera of butterflies aroused a great deal of opposition, for he upset much of the current nomenclature and divided up the old genera. To-day, much of this work is widely accepted, and while it is probable that several of his generic groups should not be regarded as valid, there remains no doubt that he was right in principle. He was, in fact, one of the pioneers in the movement for more precise classification, like Gill in fishes and Pilsbry in Mollusca.

It will be of interest to very briefly review Scudder's work in different groups.

Fishes.—While with Agassiz, Scudder worked on fishes, and prepared some manuscripts which he did not publish. Some of this

work was published by others, so that in the family Hæmulidæ two genera and one species are to-day credited to Scudder.

Crustacea.—*Rhachura venosa* was published as a new genus and species of fossil Crustacea, and is accepted as valid. For some reason, it is erroneously printed *Rachura* by Weller and others.

Arachnida.—One living spider from Nantucket was published, *Lycosa arenicola.* In 1904 this became the type of the genus *Geolycosa* Montgomery. Thirteen species of Paleozoic and thirty species of Tertiary arachnids were published.

Myriapoda.—Scudder published 32 species of Paleozoic myriapods and one from the Tertiary rocks. The work on the Paleozoic forms was very interesting and important.

Fossil Insects.—The following figures are obtained by going through Handlirsch's great work on fossil insects, and my own (1909) list of the Tertiary genera. In the latter paper five genera of Canadian Homoptera are accidentally omitted.

	Genera	Species
Carboniferous	44	116[2]
Permian	5	76
Lias		6
Jura	5	23
Cretaceous	2	2
Tertiary	177	838
Quaternary		83
Total fossil insects	233	1,144

Although Scudder had the reputation of being an excessive "splitter" as to genera, it is to be noted that Handlirsch has actually proposed 33 new generic names for or including Scudder's Carboniferous species.

Having myself done much work on fossil insects from Florissant, where Scudder obtained so much of his material, I can testify to the general excellence of his work, while its amount is simply astonishing. He made some mistakes, and certainly described a number of specimens which were too poorly preserved to be satisfactorily classified; but he was to American paleoentomology as Leidy, Cope and Marsh combined were to our vertebrate paleontology. Indeed there is little doubt that in respect to the proportion of good work to bad, or of valid genera and species to invalid, Scudder appears in a most favorable light in comparison with the great paleontologists mentioned.

[2] Also four species later considered by Scudder to be the remains of plants.

Recent Insects

Orthoptera.—Mr. J. A. G. Rehn says: "He was the greatest orthopterist America has produced," a fact nobody could be found to dispute. On going through Kirby's "Catalogue of the Orthoptera of the World," I find 106 genera and 630 species credited to Scudder, and two additional species to Scudder and Cockerell. Most of these are North American, but many are exotic, especially from the Andes and the Galapagos Islands.

Odonata (dragon-flies).—Scudder worked only for a short time on dragon-flies, but the results were important. Muttkowski's Catalogue (1910) credits six species and one subspecies to Scudder.

Lepidoptera Rhopalocera (butterflies).—The work on butterflies was of the first importance, and has been referred to above. The description of new species was a quite minor aspect of it, but I find in the North American fauna nineteen species credited to Scudder, and five to Scudder and Burgess. There are also numerous subspecies or varieties. More important was the treatment of genera. Dyar's Catalogue (1902) gives 44 valid genera described by Scudder; but Skinner's later list, representing the ideas of the older school, recognizes only one Scudderian genus, though some others are accepted and wrongly credited to Speyer. In all, I find that Scudder described 1,884 apparently valid species of animals.

It remains to note that Scudder came of good stock, two of his brothers having attained eminence. The older (born 1835), David Coit Scudder, was a missionary of note, who died in India. His "Life and Letters" were published by Horace Scudder in 1864. The younger brother (born 1838) was Horace Elisha Scudder, well known as a writer of stories for children and other works, and later as the editor of the *Atlantic Monthly.* Vida

D. Scudder, also well known as a writer, is a daughter of David C. Scudder.

T. D. A. COCKERELL

SCIENTIFIC NOTES AND NEWS

DR. E. A. SCHAFER, professor of physiology at Edinburgh, has been elected president of the British Association, for the meeting to be held next year at Dundee, beginning on September 4. The meeting of 1913 will be held at Birmingham.

As part of the celebration of the centenary of the University of Christiania a number of honorary degrees were conferred upon the following American men of science: William Morris Davis, of Cambridge, geographer and geologist; William Lewis Elkin, of New Haven, astronomer; Albert Abraham Michelson, of Chicago, physicist; Henry Fairfield Osborn, of New York, paleontologist; Theodore William Richards, of Cambridge, chemist; Charles Doolittle Walcott, of Washington, geologist, and Ludvig Hektoen, of Chicago, pathologist.

THE Prussian gold medal for science has been conferred on Dr. Wilhelm Waldeyer, professor of anatomy in the University of Berlin.

DR. S. J. MELTZER, head of the department of physiology and pharmacology at the Rockefeller Institute for Medical Research, has been elected a member of the Imperial Leopoldina Carolina Academy of Naturalists, at Krakau.

WE regret to learn that Dr. Thomas Dwight, professor of anatomy at Harvard University, is seriously ill at his summer home at Nahant.

DR. CHARLES L. PARSONS, professor of chemistry in New Hampshire College since 1892, has accepted the position of chief mineral chemist in the Bureau of Mines, Washington, in charge of miscellaneous mineral technology. In the same bureau, Professor F. G. Cottrell, of the University of California, has been appointed chief physical chemist, in charge of the western metallurgical field.

THE Rockefeller Institute for Medical Research announces the election of Dr. Theodore C. Janeway as a member of its board of scientific directors, to fill the vacancy caused by the death of Dr. C. A. Herter. This board has the entire control of the scientific work done by the institute. Its other members are Dr. William H. Welch, of Baltimore, Dr. Theobald Smith, of Boston, and Drs. L. Emmett Holt, Herman M. Biggs, T. Mitchell Prudden and Simon Flexner, of New York.

PROFESSOR GIES, Columbia University, was recently elected a scientific director of the New York Botanical Garden to succeed Professor Charles F. Chandler.

THE *Journal* of the American Medical Association states that a committee has been organized to do honor to the one who has been so largely responsible for the progress realized in the knowledge of diseases of tropical countries, Sir Patrick Manson, the movement for the international manifestation having been started in France. It is proposed to present him with a portrait medal, in gold, the work of Dr. Paul Richer, professor of anatomy at the Beaux-Arts in Paris. The forty-five members of the committee represent the leading countries of the globe; the list includes Drs. W. H. Welch, G. N. Calkins, F. G. Novy, C. W. Stiles and H. B. Ward of this country.

A DELEGATION named by Professor Alexander Smith, head of the department of chemistry of Columbia University, to represent the American Chemical Society at the National Conservation Congress in Kansas City the last of the month has been announced. It is composed of Professor E. H. Keiser, Washington University, St. Louis; Chancellor Samuel Avery, University of Nebraska; Professor Herman Schlundt, University of Missouri; Professor H. S. Bailey, University of Kansas, and Dr. H. E. Barnard, State Laboratory of Hygiene, Indianapolis.

THE president of the British Board of Education has appointed Dr. Francis Grant Ogilvie to the post of director of the Science Museum, which he will hold in addition to his present office of secretary for the Science Museum and Geological Survey and Museum.

CAPTAIN LYONS, F.R.S., has resigned from the lectureship in geography at University of Glasgow.

ADMIRAL HERZ has retired from the directorship of the German Nautical Observatory at Hamburg.

MR. T. SHEPPARD, of the Hull Municipal Museums, has been appointed expert adviser to the new public museum at Scunthorpe.

MR. WILLIAM MARCONI has been at St. Johns, N. F., conducting experiments with the object of ascertaining the advisability of installing a more powerful station on the spot where his first wireless telegraph tests were made.

MR. ARTHUR ALLEN, to whose expedition to Colombia attention was recently called in SCIENCE, goes as a representative of the Department of Birds and Mammals of the American Museum of Natural History.

PROFESSOR JUNIUS HENDERSON, of the University of Colorado, has spent the greater part of the summer in North Park and Middle Park with one of the State Geological Survey parties. He has been working out the stratigraphic positions of the various sedimentary formations. Large collections of fossils were obtained, as well as living land and freshwater mollusks.

SIGNOR CALISSANO, Italian Minister of Posts and Telegraphs, accompanied by telegraphists who had assembled at Como from all parts of the world, went on September 1 to Camnago to pay a visit to the grave of Alessandro Volta, the inventor of the electric battery which bears his name. The minister and delegates placed wreaths on the tomb, and Signor Calissano, Signor Battelli, a member of the Italian Chamber, M. Buels, director of the Belgian Telegraphs, and Signor Pietro Volta, a nephew of the inventor, made speeches. A memorial stone was unveiled bearing an inscription recording the esteem in which Volta is held by telegraphists all over the world.

DR. FRANCIS A. MARCH, professor emeritus of comparative philology and English literature at Lafayette College, and eminent for his contributions to the scientific study of language, died on September 9, aged eighty-six years.

DR. ALBERT LADENBURG, professor of chemistry at Breslau, and distinguished for his researches in organic chemistry, died on August 15, aged sixty-nine years.

DR. LOUIS C. DE COPPET, known for his work in physical chemistry, has died at Nice, at the age of seventy years.

REVEREND F. J. JERVIS-SMITH, F.R.S., late university lecturer in mechanics at Oxford, died on August 23, aged sixty-three years.

MASUCHIKA SHIMOSE, a Japanese chemist who gave his name to the Shimose powder, died on September 6, aged fifty-two years.

OF the seventy-five doctorates in philosophy conferred by Columbia University this year, nine were in chemistry and one in physics. In the report published in SCIENCE on August 18, those who presented theses on the weight of a falling drop were attributed to physics instead of to chemistry.

THE fourth annual meeting of the American Institute of Chemical Engineers will be held in Washington, D. C., Wednesday to Friday, December 20 to 22. A number of papers will be presented on the general subject of patents, and the manufacture and testing of explosives as well as of a number of other chemical engineering subjects. One day will probably be devoted to visits to the technical chemical engineering plants in Baltimore and vicinity. Visits to laboratories and other points of interest in Washington will also be arranged for.

THE seventh International Congress for Criminal Anthropology will meet at Cologne, from October 9 to 13.

MRS. E. H. HARRIMAN has given $50,000 for the establishing of a bacteriologic and pathologic laboratory to be attached to the present Southern Pacific General Hospital, San Francisco. It is to be known as the Harriman Memorial Laboratory.

WE learn from the *Journal* of the American Medical Association that the second field commission for the investigation of pel-

lagra has left London for the continent. It is composed of Dr. Louis Sambon, lecturer, London School of Tropical Medicine and parasitologist to the Wellcome Physiological Research Laboratories, and Dr. Albert T. Chalmers, lecturer on pathology and animal parasitology, Ceylon Medical College. These two members of the commission will be joined *en route* by Professor Haase, of Memphis, U. S. A., Dr. Cole, of Atlanta, U. S. A., and Dr. Martinez, of Yucatan, Mexico. The commission will proceed to the study of the epidemiology and etiology of pellagra in Hungary, the Austrian Tyrol, Spain, and the south of France. The governments of Austria-Hungary and of Spain have shown interest in the work and have granted every facility for prosecution of the study. Mr. H. S. Wellcome has defrayed the expenses of the present field commission. The work in Italy in the spring of 1910, by Dr. Louis Sambon, has gained many converts to the belief that pellagra is not due to eating damaged maize, but to a parasitic disease conveyed by the bite of a fly.

In constructing the huge topographic and geologic maps of the United States every detail of the work is done by the survey, from the work of the topographers who make the maps in the field down through the various stages of drafting, lettering, editing, engraving and lithographic printing in many colored inks. There is practically no compilation about the survey maps; they are based on surveys made on the ground, and the office work consists simply in putting them into form for issuance to the public. They depict most faithfully the characteristics of the areas surveyed. Every year with the coming of the open field season numerous survey parties hurry away from the Washington office to the four quarters of the United States as well as to Alaska, and the result of their season's work is the topographic and geologic mapping of tens of thousands of square miles of all sorts of country ranging from the most forbidding swamps and morasses to the loftiest of the glacier-covered mountains of the Rockies and the high Sierra, and including the most valuable mineral deposits of the nation. While these parties are thus traversing untrodden fields, the survey's engraving and printing plant throughout the summer, as in fact through all the year, is turning out hundreds of thousands of copies of the results of the previous year's field work. In a single midsummer month this year the survey plant printed 102,404 topographic maps, 5,345 geologic folios, each containing many maps, and 111,170 copies of other geologic maps, charts, etc. Besides its own maps a great number of maps are also printed by the survey engraving division for other branches and departments of the government. Stephen J. Kübel, chief engraver, has run this extensive engraving and printing plant under the director of the Geological Survey for the past 22 years. Years ago he instituted an almost exact cost-keeping system which has enabled him to enter into close competitive bidding on some of the government contract work and to run the engraving plant on thoroughly up-to-date business lines. Most of the maps are printed in colors and for the total number of 218,919 maps and charts printed during the month mentioned the number of separate printings or impressions was 1,287,609. The geologic map of North America, which is now being printed in four sheets, shows 42 different color and pattern distinctions. Each sheet requires 20 separate printings, and the 13,700 copies of the southwest sheet of this map printed during the month necessitated 274,000 printings. The total edition of 13,700 copies of the complete map has required 1,096,000 printings.

In the course of his speech in the British parliament on the Indian Budget, the under secretary for India said: "The most urgent need is the education of the masses in the principles of hygiene. There is a limitless field, indeed, for private enterprise here. Tolerable though archaic habits and practises may be in the open country, when transferred to the crowded town they become unsupportable. If there were less ignorance and less perversity, plague would never find in the country the lodgment that it has. It is an established fact that persons living under proper sanitary

conditions are virtually exempt from the disease. Plague does not attack the gaol population or the native army; it attacks the ordinary civil population, because they live in houses which are not rat-proof, because they treat the rat almost as a domestic animal, because large numbers of them refuse to trap or kill it, and because they will not adopt the sanitary precautions which are pressed upon them. Plague has now been present in India for fifteen years, and the appalling total of nearly 7,500,000 deaths from it has been recorded. Of this the Punjab accounts for nearly two and a half million deaths—almost a third of the total. The tale of deaths in the last ten years represents 1 per cent. of the population of that province. When I think of the sensation that was caused in this country a short time ago by what was by comparison a minor outbreak in Manchuria, resulting in only 50,000 deaths, I fear that people in this country do not realize the awful ravages that this scourge is daily making among the Indian people. Scientific research has established that it is conveyed by rat fleas to human beings. The two effective remedies are inoculation and house evacuation. Professor Haffkine has discovered a vaccine by which comparative though not absolute immunity can be temporarily secured. But by an unhappy accident at Mulkowal several villagers died of tetanus after inoculation. Inoculation in India has never recovered from this disaster. It is hated by the people and avoided by them except when the disease is in their midst. House evacuation is easier in villages than in towns. Administrative arrangements by which plague is now fought include the provision of special plague medical officers and subordinates, and they and the district staff are on the lookout for the occurrence of plague, and when it occurs they visit the locality, offer inoculation, give assistance to persons to vacate their houses, advise rat destruction, and so on. To the prevention of plague there would seem to be no royal road. The case is one in which lavish expenditure of money is not called for, and would be useless. But the provincial governments have spent, and are spending, a good deal. The United Provinces have expended some £600,000 up to date. The Punjab government is spending about £40,000 a year. The improvement of the general sanitary conditions under which the population lives is more and more clearly seen to be essential, and to improve them the local governments are devoting all the money they can spare. They have been helped to do so by the grants for sanitation made by the government of India. The scientific difficulties are enhanced by the difficulty of overcoming prejudice and ignorance, habit and apathy. In some districts there is actually religious objection to rat-killing and inoculation. No better work can be done for India than to offer example and instruction in principles of life that appear to us elementary, and to strive to exorcise the foes of progress—superstition and resistance to prophylactics. There are, I am glad to say, signs that the sanitary conscience is beginning to awake among the people."

UNIVERSITY AND EDUCATIONAL NEWS

PROFESSOR WILBUR J. FRASER has resigned as head of the department of dairy husbandry of the University of Illinois to devote his entire time to a professorship which he will retain within the department. Professor Fraser has been head of this department since its organization some fifteen years ago, during which time it has grown until it now numbers twelve members and its resources amount to over fifty thousand dollars annually exclusive of receipts.

W. C. RUEDIGER has recently been advanced from assistant professor to professor of educational psychology in the Teachers College of the George Washington University.

THE following new appointments have been made at the University of Colorado: Max M. Ellis, Ph.D. (Indiana), instructor in biology; Arthur G. Vestal, B.A. (Illinois), instructor in biology; Paul M. Dean, M.A. (Colorado), instructor in chemistry; Harold E. Robbins, M.A. (Yale), instructor in physics; Whitney C. Huntington, B.S. (C. E.) (Colorado), for the past year assistant, instructor in civil

engineering; Rex E. Edgecomb, B.S. (C. E.) (Iowa State), instructor in civil engineering; Charles D. Fawcett, B.S. (E. E.) (Colorado), instructor in electrical engineering; Frank S. Bauer, B.S. (M. E.) (Illinois), instructor in mechanical engineering; Herbert D. McCaslin, B.S. (M. E.) (Purdue), instructor in mechanical engineering; J. B. Hanson, A.B. (Missouri), instructor in physiology and pharmacology.

DISCUSSION AND CORRESPONDENCE

M. COSSMANN ON THE PHYLOGENY OF CERITHIUM

In the *Revue Critique de Paléozoologie* for April, 1911, M. Cossmann published a review of my paper on "The Phylogeny of Certain Cerithiidæ" which involves a question of fundamental principles in the study of phylogeny and is therefore of interest to consider at greater length.

M. Cossmann calls attention to the fact that my classification differs widely from that published in his monograph on the Cerithiidæ.[1] The reason for this is, as stated in my paper, that we are following entirely different methods of work. We are, I think, in accord in assuming that a natural classification should be based upon descent from a common ancestor but as to the principles to be followed in determining relationship we differ widely. M. Cossmann's classification is based on a comparison of the aperture and especially of the "cerithial" canal, mine upon the entire ontogeny of the shell, the facts thus obtained being applied in accordance with Haeckel's biogenetic law. M. Cossmann's argument in favor of using the aperture as a basis of classification is stated in his review as follows: "C'est par l'ouverture que sortent les organes d'un Gastropode, c'est par là que son manteau secrète le test; c'est donc l'ouverture qui joue le principal rôle dans l'évolution." It is true that the mantle secretes the shell at the aperture, but if the adult aperture be considered of so much importance how can we neglect the succession of apertures represented by the young shell every growth line of which outlines the aperture of the shell at the time when the line was formed. If it be true, as stated by Hyatt,[2] that "All modifications and variations in progressive series tend to appear first in the adolescent or adult stages of growth" we shall find in the adult aperture the extreme limit of variation for the individual, and it is to this stage that we look for divergence from the well established, hereditary characters that ally the organism with its ancestors. If recapitulation be a fact it is in the young stages that inherited characters find their fullest expression. A defense of the methods used in my paper and of my results is simply a defense of the theory of recapitulation, and no adequate presentation of the subject can be attempted in a limited space. The validity of the theory is still questioned by some scientists, mainly zoologists, but the final answer to the question will be, as in the case of the theory of evolution itself, an accumulation of corroborative facts so overwhelming as to finally silence doubt. Already the accumulation of such facts is so considerable as to convince nearly all paleontologists and many zoologists. In an excellent summary of the present status of opinion on this subject Cumings[3] has called attention to illustrations of recapitulation in each of the classes of invertebrates above the Porifera.

Against this mass of evidence a mere dogmatic statement has little weight. It is not enough to cry scornfully, "Quelle importance peut-on attribuer à des conclusions basées sur de telles prémisses?" He who would show these premises to be unsound must show Haeckel's law to be invalid by answering the arguments of Hyatt, Cope, Jackson, Beecher, Cumings and many others, and also otherwise account for the great accumulation of evidence in favor of the law which appears not only in the works of authors avowedly in favor of the theory but in the facts presented

[1] M. Cossmann, "Essais de Paleoconchologie Comparée," VII., July, 1906.

[2] A. Hyatt, "Genesis of the Arietidæ," p. ix, Smith's Cont. to Knowledge, No. 673, 1889.

[3] E. R. Cumings, "Paleontology and the Recapitulation Theory," *Proc. Ind. Acad. Sci.*, 25th anniversary meeting, 1909.

by many other workers whether they call attention to the recapitulation shown or not.

As a whole M. Cossmann's criticism shows a total misconception of modern methods in phylogenetic study and even the illustrations which I have used to point out likeness or difference in descent are to him, judging as he does by the standards of the older conchologists, only so many offences against the good old fashioned rule of putting together species that are alike in the adult and ignoring "simples et légerès modifications dans l'ornamentation de la spire." A careful comparison of the detailed figures in my paper will, however, show that the modifications are not slight in cases where genera are separated.

As might be expected, the choice of a genotype from the work of a pre-Linnean author is questioned. This choice arose from the difficulty of applying the established rules of nomenclature in such a manner as to meet the approval of all students of the subject. Bruguière, the first post-Linnæan author to use the binomial nomenclature in connection with *Cerithium*, did not select a genotype, and Lamarck chose, at different times, two of Bruguière's species as illustrations of the genus. At present one eminent authority chooses as genotype the first of Lamarck's selected species, while another chooses the second and a third suggests a choice from Bruguière's many species. If the general consensus of opinion finally fixes upon *Pseudovertagus aluco* or *Cerithium? nodulosum* instead of *C. tuberosum* as the type of *Cerithium* it would simply necessitate the choice of a new name for the group represented by *C. tuberosum, C. adansoni*, etc., which were the first to be described, and which have long been known by that name. However, the name applied to a natural group is of minor importance. The point of especial importance is that such shells as *Pseudovertagus aluco* and *Cerithium echinatum*, for example, can not be classed together in the same genus since their ontogeny shows that they have an entirely different ancestry. The main object of my paper is to trace the phylogeny of a natural group and to show the methods by which relationship should be determined.

In summarizing I would emphasize the following three points:

1. A natural classification should be based on community of descent.

2. In tracing descent the whole ontogeny is a more reliable guide than a single final stage of it.

3. There is sufficient evidence in favor of the theory that ontogeny recapitulates phylogeny to make it the only safe means of determining relationship.

Elvira Wood

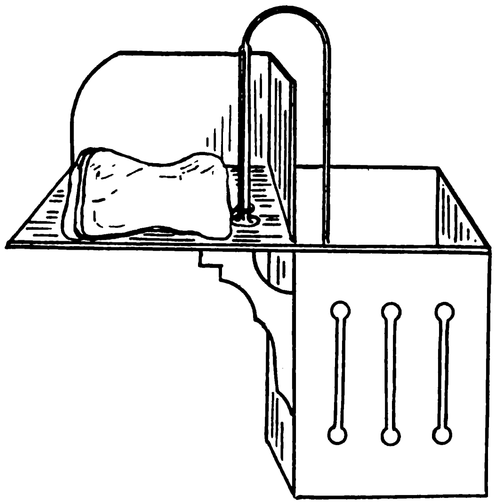
Columbia University,
May 31, 1911

A NEW RACK FOR INDIVIDUAL TOWELS

The "common towel" is a problem which sanitarians so far have failed to solve. This is especially true of the roller towel so often found in public places. The fact that these towels are dirty and unattractive, if not repulsive, is comparatively unimportant, for if the real facts were known it would be understood that many cases of disease are transmitted by this means. In the better places where the wash room can have frequent attention, small individual towels can be used. In a good many places, however, it seems impossible on account of the expense, due to those lost and stolen. One attempt to solve the problem has been the substitution of paper for cloth towels. In the minds of most people, however, these paper towels are not satisfactory, although, of course, they are perfectly hygienic.

An attempt has been made at the University of Wisconsin to solve this problem and towel racks have been designed which make it possible for each person to have an individual towel. This rack is very simple, as is seen in the accompanying illustration. It consists essentially of a shelf on which are placed a pile of the small, clean towels, and just below this and at one side is a receptacle or basket into which the dirty towels are placed. Connecting the shelf and the basket is a rod with a goose neck. The towels are provided with a perforation or loop through

which this rod passes, so that when a towel has been used it is slipped over the rod and



allowed to drop into the basket. This rod is ordinarily held in place by a nut, but it might be provided with a lock. It would thus be impossible to remove the towels by any one not provided with a key without tearing them.

This rack has been used at the university, in its various toilet rooms, for some months with much satisfaction.

W. D. Frost

University of Wisconsin

QUOTATIONS

THOUGHT-TRANSFERENCE

A curious offer, or challenge, has been appearing recently in our columns. An unnamed inquirer asks for "satisfactory proofs of so-called thought-transference"; and, as such proofs have not been forthcoming in response to applications to "the leading authorities and writers of repute on the subject," a reward of £1,000 is now offered to any one who will furnish them. We understand those who use the expression "thought-transference" to mean by it that, under conditions at present undetermined, the physical changes underlying the thought processes of a human brain may be brought into such relations with some unknown medium of communication as to be conducted through its agency to another human brain, and to produce in the latter changes, and consequently thoughts, analogous to or identical with those preexisting in the former; the process being somewhat analogous to the communication of Hertzian waves from their source to a suitable receiver at a distance. The foundations of any such belief must manifestly rest upon the instances in which it is said that human beings, separated by distance, have been simultaneously the subjects of thought impressions of a similar or identical character, on matters important or interesting to both; and it is equally manifest that no "proof" of "transference" in such cases could possibly be given. The instances, or supposed instances, have never been examined with sufficient care by competent persons to exclude the innumerable possibilities of coincidence, and it is even doubtful whether any care which could be taken, after the alleged event, would be sufficient for the purpose, or could avoid the operation of "the myriad shafts of chance." The only conclusive proof would be by the intentional reproduction of the occurrence; and in order to accomplish this it would first be necessary to determine with scientific precision what were the conditions of success. If there can be a transference of the kind alleged, it must occur as a result of a state of things which, if its nature were precisely known, could be reproduced with certainty; but which, so long as it is uncertain or undefined must continue to elude observation and to baffle experiment. If "proof" be desired, it should be sought by endeavors to reproduce in a physical laboratory the circumstances which have given rise to the stories about thought-transference.—The London *Times*.

SCIENTIFIC BOOKS

Quantitative Mineralogical and Chemical Composition of Granites and Gneisses. By Professor T. Tchirwinsky. Moscow. 1911. 8vo. Pp. vii + 659, 4 plates.

An important work by Professor T. Tchirwinsky on the quantitative chemical and

mineralogical composition of granites and gneisses has just been issued. This tireless worker in the fields of mineralogy and petrography presents in this his latest work a very thorough study of his subject, and offers a large mass of materials derived from the best sources and supplemented by the results of his own investigations. The details are so grouped as to be easily utilized by those who may consult the volume. The importance of a correct determination of the composition of granite rocks for an understanding of the genesis of mineralogical forms in general does not need to be emphasized.

The author begins his exposition with an examination and description of the different methods used in determining the quantitative composition of rocks (pp. 11–75), a thorough understanding of the various methods being essential for the appreciation of their respective value in controlling the results arrived at by any one of them. The purely chemical methods are first described, it being shown that the investigation of the mineralogical composition of granite should begin with a determination of the quantity of magnesia present in the biotite or biotitic granite. A table on page 14 shows the differences in relative percentage of the constituents of orthoclase, albite and anorthite, as conditioned by the later and earlier computations of the atomic weight of the elements; the first column gives the figures arrived at or according to the standard of 1907, and the second and third columns the figures according to earlier standards—the third column referring to the early sixties.

The method followed by Haughton in his analyses of Leinster granite—wherein he recognized as the three principal constituents, feldspar, margarodite and quartz—and that followed by Sartorius von Waltershausen in the investigation of basalts, are given at considerable length (pp. 17–33). The author then explains the method of determination by the use of reagents and finally proceeds to a consideration of the purely mechanical methods. He gives the preference to that used by Delesse—as early as 1848—and modified and improved by later investigators.

As many of the results secured by Professor Tchirwinsky were obtained by the use of this method, we give briefly his description of it, as used by him. Upon the plate to be examined a network of points is made with ink. The interval between the single points and the width of the network are determined by the magnification to be used. The point at the upper left-hand corner is first brought to the center of the cross-threads over the object glass of a microscope, the instrument resting in a horizontal position in a Winkel or Leitz apparatus for microphotography. In place of the ground-glass disk, a disk of transparent glass is inserted in the apparatus, and a piece of tracing paper is attached to the glass with wax. Under artificial illumination of the apparatus in a dark room, a sharp, clear picture of that portion of the plate surrounding the point is projected on the paper and is traced there with a pencil. Similar minerals are designated by given letters and are afterwards cut out. The same process is followed with all the points.

More than 400 pages (pp. 77–495) are devoted to tables, arranged geographically, exhibiting the results of analyses of granites and gneisses. The various data are examined critically, and are supplemented by the results of numerous tests made by the author according to the Delesse method. These are given at great length in the case of each plate tested, with the average value. The material here assembled is very valuable and of great interest to the petrographer.

This section is followed by one presenting the conclusions drawn by the author from the material he has brought together (pp. 501–659). Here the manifold characteristics and the average chemical composition of the several minerals that appear in granite are studied, as for example the feldspars, biotite, hornblende, pyroxene, quartz, etc., and the quantitative chemical and mineralogical composition of granite, pegmatite-granite,

aplite and myrmecite are considered. It is not possible within the limits of this brief notice to do more than draw attention to the cosmographical significance attributed to the granites by Professor Tchirwinsky and his opinion of the place they occupy in the earth's crust (pp. 645–654). He believes that granite is only to be found in the outermost part of the crust, and that it plays a very small part in the upbuilding of our planet. This conclusion is drawn from the relation of the mean specific gravity of granite to that of the earth. The average specific gravity of the basic eruptive rocks, according to figures for gabbro, diabase, basalt and diorite, as given by Osann, is about 2.9; that of granite is from 2.67 to 2.68 (p. 636). Now it is computed that the specific gravity of the earth's crust to a depth of 4,000 meters only is on the average 3.13. This would indicate that the granite formations are comparatively superficial. In this connection it is interesting to note that the mean specific gravity of the moon, which Professor Tchirwinsky terms "the sister or the daughter of the earth," and that of the meteorites, is from 3.4 to 3.5. Much importance is based upon the absence of magnesia, and the associated biotite; the latter is only of rare occurrence and magnesia is one of the least plentiful of the constituents so that it could be questioned whether its presence is of much or any importance.

There are three things to be regarded in a volume of such magnitude as the work of Professor Tchirwinsky. We regret that a communication of such value as he sets forth in his work should be published only in the Russian language, an unfortunate circumstance for most workers who understand only English, German or French.

Second, many of the analyses quoted are old ones; the more recent ones by American analysts having been omitted. This is regrettable since they would have greatly increased the value of the deductions.

Nevertheless the work is a monument of great value and as a contribution to petrology, of great importance.

George Frederick Kunz

De Rietsuikerindustrie in de Verschillende Landen van Productie. H. C. Prinsen Geerligs. Pp. xviii + 416 + xxiii. Amsterdam, J. H. De Bussy. 1911.

This is the fourth volume of a hand-book of sugar-cane culture and cane-sugar manufacture, published by the Iavanese sugar-experiment stations, a work of great value and importance for the sugar industry.

The author first gives a concise historical review of the sugar industry from the earliest times and then passes on to describe in detail the cane industry of all countries—some forty-odd in number—at the present time.

Prinsen Geerligs considers his theme from the historical, the technical and the economic point of view; he enters into the geographical and the climatic conditions of each country, discusses the technical evolution of the industry, studies the bounty question, and gives copious data on the consumption and export of sugar in the several countries.

A number of charts, diagrams and maps, as well as sundry illustrations, scattered throughout the book, add greatly to the elucidation of the immense amount of material brought together within these pages, material nowhere else available in so convenient a form.

Issue of a publication of this kind, a publication of importance to workers in many sections of the globe, causes one to voice regret that it should have appeared in Dutch, a language known to but comparatively few. There certainly is need of a true world language in which all works of great and general interest should be published and thus prove accessible to all without expenditure of the additional labor of translation and loss of time.

It is to be hoped that this book may soon appear in one or more of the leading tongues —an English version, certainly, would be sure of a warm welcome. F. G. Wiechmann

The Reduction of Domestic Mosquitoes: Instructions for the Use of Municipalities, Town Councils, Health Officers, Sanitary Inspectors and Residents in Warm Climates. By Edward Halford Ross, M.R.C.S. Eng-

land. Philadelphia, P. Blakiston's Son & Co. 1911. Pp. 114, with eighteen maps and illustrations.

This is an attractive and well-printed work, yet withal a great disappointment. The principal title, "The Reduction of Domestic Mosquitoes," covers so fully one of the present great needs in the book line, that it is a distinct shock to discover that it practically applies "in warm climates" only. Mr. Ross was "late health officer, Port Said and Suez Canal District," and his practical experience seems all to have been gained in those localities. He tells, most interestingly, of the methods there adopted, of the difficulties encountered with the native population and of the successes attained. But the smallest portion of all this is applicable, except in the most general way, to American (United States) conditions.

Nearly half the book is taken up with generalities, telling of the life history of the domestic mosquitoes, by which he means chiefly the *Stegomyia fasciata* (yellow fever carrier) and *Culex fatigans* or *pipiens* (ordinary rain-barrel mosquito) and how objectionable they are. There is nothing new in this and the information is not even reasonably complete. American work is scarcely referred to at all and even the New Orleans, Havana and Panama work receives only more than a mere mention. It is perhaps natural that Theobald's work should be the only one considered worthy of mention from the systematic standpoint; but surely from the practical point of view the work done by Dr. Howard and his assistants in the U. S. Department of Agriculture deserves at least some notice.

Some of the statements concerning the life cycle are perhaps open to question, unless there is a greater difference between *C. fatigans* and *C. pipiens* than is usually supposed, and so in the brief consideration of natural enemies, not all can be considered strictly applicable to our conditions. Some of the matters are absolutely incorrect, as where waterboatmen or "backswimmers" (*Notonecta*) are credited with catching wrigglers and pupæ in their "jaws"—appendages which they do not possess. That there may be no doubt of the mix-up, it is said that "it is a water-beetle," instead of as should be, a water-bug.

The importance of the mosquito work and the difficulties are not minimized and that a really effective campaign is an expensive matter is well brought out; but unfortunately the calculations and the preliminary work required do not fit or even serve as fairly accurate guides to conditions in those sections of the United States where "the reduction of domestic mosquitoes" is just now considered rather a timely matter, and the figures supplied would discourage the average American municipality if offered as a basis of an effective campaign.

JOHN B. SMITH

NEW BRUNSWICK, N. J.,
August 23, 1911

SCIENTIFIC JOURNALS AND ARTICLES

THE number of the *Journal of Medical Research* issued in September contains the following articles:

"The Vaccination of Cattle against Tuberculosis. II.," Theobald Smith.

"Organic Matter in the Expired Breath," Milton J. Rosenau and Harold L. Amoss.

"A Study of Primary Intimal Arteritis of Syphilitic Origin" (with one plate), Fraser B. Gurd and H. W. Wade.

"The Rapid Isolation of Typhoid, Paratyphoid and Dysentery Bacilli," Arthur I. Kendall and Alexander A. Day.

"An Investigation on the Permeability of Slow Sand Filters to Bacillus Typhosus," Edward B. Beasley.

"Certain Fundamental Principles Relating to the Activity of Bacteria in the Intestinal Tract," Arthur I. Kendall.

"Tuberculosis among Ground Squirrels (*Citellus beecheyi* Richardson)," George W. McCoy and Charles W. Chapin.

"Precipitation Tests for Syphilis," Lawrence W. Strong.

"Notes on Twenty-two Spontaneous Tumors in Wild Rats (*M. Norvegicus*)" (with one plate), Paul G. Wooley and Wm. B. Wherry.

"The Isolation of Typhoid Bacilli from Urine and Feces," F. F. Russell.

"The Isolation of Bacillus Typhosus from Butter," D. H. Bergey.

"Note on a Peptid-splitting Enzyme in Woman's Milk," Louis M. Warfield.

"Carcinoma Involving the Entire Kidney" (with two plates), Lindsay S. Milne.

"A Study of a Case of Thrombo-angitis Obliterans," Harlow Brooks.

"The Value of the 'Hormone' Theory of the Causation of New Growth," I. Levin and M. J. Sittenfield.

The contents of the *Astrophysical Journal* for September are:

"Spectrum of Comet Morehouse (1908 *c*)," A. de la Baume Pluvinel and F. Baldet.

"The Discovery of Eclipsing Variable Stars," Joel Stebbins.

"A New Bright Variable Star, β *Aurigæ*," Joel Stebbins.

"Motion and Condition of Calcium Vapor over Sun-spots and other Special Regions. II.," Charles E. St. John.

"An Enclosed Arc for Spectroscopic Work," James Barnes.

"The Spectra of Aluminium, Copper and Magnesium in the Arc under Reduced Pressure," James Barnes.

"An Inquiry into the Variation of the Spectroscopic Binary κ *Pavonis*," Alex. W. Roberts.

SPECIAL ARTICLES

THE ORIGIN OF THE GREAT PLAINS

Passarge's dictum that "Wasser ist nicht im Stande solche Ebene zu erodieren" now seems eminently applicable to vast, arid and remarkably smooth plains other than those of the great South African plateau. In the light of the recent advances in our knowledge of general desert-leveling, or regional planation and lowering without base-leveling, the vastness and evenness of the Great Plains lying between the Rocky Mountains and Mississippi River at once raise the query whether genetically their dominant characters have been properly interpreted.

At the present time the geologic formations receiving greatest critical attention are those known as continental deposits, or terranes laid down and preserved on land instead of in lakes or seas. In the recent considerations of the subaerial formations so many novelties enter that in many an old and well-known field a new interest is aroused. The Great Plains and their deposits are one of these. On a grand scale they appear to introduce to us a mode of terranal genesis hitherto almost unrecognized. Continental deposits thus begin to assume in this country an importance which has never been before accorded them.

Singularly enough, the so-called fresh-water Tertiaries of the Great Plains have had ascribed to them every known method of origin. The same is true of the surface-relief. In the descriptions and discussions of this one geologic formation and of this single topographic feature is reflected in all its various phases a century's trend of sedimentative and physiographic thought in America. For this reason, if for no other, the theme is deserving of more than passing notice.

The origin of the Great Plains and their deposits has been ascribed to (1) normal marine deposition, (2) lacustrine sedimentation in vast bodies and (3) fluviatile aggradation. To these hypotheses must now be added a fourth—that of eolative planation. In the extreme west in front of the Rocky Mountains is a belt of deflative character where often the substructure forms a typical rock-floor. In the broad median belt eolian deposition to vast extent has taken place, and is still going on. In the eastern belt along the Missouri River wind-effects, although extensive, are almost wholly obscured by moist-climate phenomena.

The two essential points to be noted are, first, continental deposits may be as important as marine or lacustrine deposits; and second, that on the American continent eolic deposits are of vast extent and are being formed under conditions whereby they may be preserved through the geologic ages as effectually as any of the marine Cambrian terranes have been.

In this new century the theory of eolic planation and deposition promises to be one of the half-dozen great and novel thoughts in the domains of geology.

Charles R. Keyes

SCIENCE

FRIDAY, SEPTEMBER 22, 1911

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SOME ASPECTS OF MODERN PETROLOGY[1]

IN accordance with the custom which permits the occupant of this chair to open the proceedings with observations on some selected subject, I wish to invite your attention to certain points concerning the genetic relations of igneous rocks. The considerations which I shall have to lay before you will be in some measure tentative and incomplete; and indeed, apart from personal shortcomings, this character must necessarily attach to any discussion of the subject which I have chosen. For petrology is at the present time in a state of transition—the transition, namely, from a merely descriptive to an inductive science—and at such a time wide differences of opinion are inevitable. If I should seem to do less than justice to some views which I do not share, I hope this fault will be attributed to the limitations of time and space, not to any intention of abusing the brief authority with which I find myself invested.

The application of microscopical and special optical methods, initiated some fifty years ago by Dr. Sorby, gave a powerful impetus to the study of the mineral constitution and minute structure of rocks, and has largely determined the course of petrological research since that epoch. For Sorby himself observation was a means to an end. His interest was in the conclusions which he was thus enabled to reach relative to the conditions under which the rocks were formed, and his con-

[1] Address of the president to the Geological Section. Portsmouth, 1911.

tributions to this problem will always rank among the classics of geology. The great majority of his followers, however, have been content to record and compare the results of observation without pushing their inquiries farther; and indeed the name "petrography," often applied to this line of research, correctly denotes its purely descriptive nature. A very large body of facts has now been brought together, and may be found, collated and systematized by a master-hand, in the monumental work of Rosenbusch. Beyond their intrinsic interest, the results thus placed on record must be of the highest value as furnishing one of the bases upon which may eventually be erected a coherent science of igneous rocks and igneous activity.

In earnest of this promise, recent years have witnessed a very marked revival of interest in what we must call at present the more speculative aspects of petrology. This manifests itself on the side of the petrographer in a growing disposition to seek a rational interpretation of his observations in the light of known physical principles, and on the side of the field geologist in a more constant regard for the distribution, mutual associations, and mode of occurrence of igneous rocks. I will add, as another hopeful sign of the times, a decided *rapprochement* between the laboratory and the field, too often treated in practise as distinct departments.

As regards the former, the movement which I have noticed is merely a return to the standpoint of Sorby, the father of modern petrology. It is true indeed that, before his time, the problem of the origin of igneous rocks had engaged the ingenuity of Scrope and Darwin, of Bunsen and Durocher, and many others; and the bold speculations of the heroic days of geology have justly exercised a lasting influence. The petrologist of to-day, however, has at his command a much ampler range of information than was possessed by his predecessors. In addition to the rich store of petrographical data already mentioned, he can press into service, on the one hand, the results of physical chemistry and, on the other, much additional knowledge which has been gathered concerning the structure of the earth's crust and the distribution of various rock-types, both in space and in time. Either of these branches of the subject would furnish material for a much longer address than my assurance could venture or your complacence would endure. I have chosen the geographical aspect of petrology; but, before proceeding to this, I will say a few words concerning the experimental side.

DATA FROM THE EXPERIMENTAL SIDE

That the modern developments of physical chemistry, starting from the phase rule of Willard Gibbs, must in theory furnish all that is necessary to elucidate the crystallization of igneous rock-magmas, has long been perceived by some petrologists. This recognition is in itself an advance. Natural rock-magmas, however, are far more complex solutions than those which chemists have employed in working out their laws, and the problem in its entirety is of a kind almost to daunt inquiry. Despite the courageous attempt made by Professor Vogt, whose enthusiastic lead has done so much to inspire interest in the subject, it seems clear that the application of the laws of chemistry to the particular class of cases with which the petrologist is concerned demands as a prerequisite a large amount of experimental work in the laboratory. The high melting-points of the rock-forming minerals, their extreme viscosity, and other specific properties render such work extremely difficult and

laborious. That most of the practical difficulties have now been overcome is due in the first place to Dr. A. L. Day and his colleagues of the Geophysical Laboratory at Washington, who have thus opened out what is virtually a new field of investigation. The methods of high temperature measurement have been perfected and the thermometric scale standardized up to 1550° C., thus embracing the whole range of rock-formation. Calorimetric measurements have been so far improved that it is now possible, for instance, to determine specific heats, even in the highest part of this range, with an accuracy ten times greater than has hitherto been usual at ordinary temperatures. Incidentally there has been, in the hands of Mr. F. E. Wright, a notable enlargement of the scope of ordinary petrographical methods, since it has been found necessary to devise special means of measuring with precision the crystallographic and optical constants of very minute crystals.

The American chemists have already determined the temperature-range of stability of numerous rock-forming minerals. Beginning with the simpler cases and working always with chemically pure material, they have established quantitatively the mutual relations of the various possible forms in a number of two-component systems and in one of three components. So far as these instances go, the mutual lowering of melting-points in a silicate-magma is now a matter of precise measurement, and it is no longer inferred, but demonstrated, that the order of crystallization of the minerals depends upon their relative proportions in the magma. The perfect isomorphism of the plagioclose felspars has been finally established, and a certain degree of solid solution between quite different minerals has furnished the explanation of some apparent anomalies, such, for instance, as the variable composition of the mineral pyrrhotite. As a single illustration of how these investigations in the laboratory provide the working petrologist with new instruments of research, I will cite the conception of a geological temperature-scale, the fixed points on which are given by the temperature-limits of stability of various minerals. It is often possible, for example, to ascertain whether quartz in a given rock has crystallized above or below 575° C., this being the inversion-point between the α- and β-forms of the mineral. At about 800° there is another inversion-point, above which quartz is no longer stable, but gives place to cristobalite. In like manner we know that wollastonite in a rock must have crystallized below 1190°, pyrites below 450°, and so for other cases. We may confidently hope that, with the aid of such data, we shall soon be enabled by simple inspection, to lay down in degrees the temperature-range of crystallization of a given igneous rock.

There are now several laboratories where high-temperature research, of the rigorous order indicated, is being carried out; but the work is peculiarly arduous and results come slowly. Some branches of the inquiry, notably those involving high pressures, and again the investigation of systems into which volatile components enter, are as yet virtually untouched. For these reasons it would be premature to hazard at this stage any more detailed forecast of the services to be rendered to petrology by synthetic experiment. I will accordingly leave this attractive subject and pass on from the laboratory to the field.

GEOGRAPHICAL DISTRIBUTION OF IGNEOUS ROCKS

Here the existing situation is very different. Instead of following out definite lines already laid down, we are concerned

in reducing to order a great mass of discrete facts drawn from many sources. The facts which enter into consideration are those touching the distribution of various igneous rocks in time, in space and in environment, including their relation to tectonic features; the mutual association of different rock-types and any indications of law in the order of their intrusion or extrusion; and, in short, all observable relations which may be presumed to have a genetic significance. The digestion of this mass of data has already led to certain generalizations, some of which are accepted by almost all petrologists, while others must be regarded as still on their trial.

Of the former kind is the conception of petrographical provinces, which was put forward by Professor Judd twenty-five years ago, and has exercised a profound influence on the trend of petrological speculation. It is now well established that we can recognize more or less clearly defined tracts, within which the igneous rocks, belonging to a given period of igneous activity, present a certain community of petrographical characters, traceable through all their diversity or at least obscured only in some of the more extreme members of the assemblage. Further, that a province possessing an individuality of this kind may differ widely in this respect from a neighboring province of like date; while, on the other hand, a striking similarity may exist between provinces widely separated in situation or in age. It is natural to attribute community of chemical and mineralogical characters among associated rocks to community of origin. The simplest hypothesis is that which supposes all the igneous rocks of a given province to be derived by processes of differentiation from a single parent-magma. This may be conceived, for the sake of simplicity, as initially homogenous, though doubtless some of the causes which contribute to promote heterogeneity were operative from the earliest stage. Granted this hypothesis, it follows that the points of resemblance among the rocks of a province will indicate the nature of the common parent-magma, while the points of diversity will throw light on the causes of differentiation. The observed sequence in time of the various associated rock-types will also have an evident significance, especially if, as there are good reasons for believing, differentiation in igneous rock-magmas is largely bound up with progressive crystallization. Those petrologists, on the other hand, who attach importance to the absorption or "assimilation" of solid rock-matter by molten magmas, are bound to consider both the nature of the chemical variation and the local distribution of the different types with constant reference to the composition of the country-rocks. The balance of opinion, and I think of argument, would assign the variation, at least in the main, to differentiation; and there are well-known principles, chemical and mechanical, which theoretically must operate to produce a diversity of ultimate products from a magma originally uniform. How far these principles are in practise adequate to the demands which have been made on them is a question not to be finally resolved without quantitative knowledge which is still a desideratum. Experiment may in time come to our aid. My design to-day is rather to offer some remarks upon a distinct, though allied, problem—viz., that presented by the petrographical provinces themselves.

The geographical distribution of different kinds of igneous rocks long ago engaged the attention of Humboldt, Boué, and other geologists, and the subject has always possessed a certain interest in view of the association of most metalliferous de-

posits with igneous rocks. It has, however, acquired a new importance in recent years in connection with questions of petrogenesis which are still under discussion. The problem is, in brief, to account for the existence of petrographical provinces and for the observed facts relative to their distribution. One theory, advocated especially by Dr. G. F. Becker, invokes primeval differences in composition between different parts of the globe, which have persisted throughout geological time. It involves the hypothesis that igneous rock-magmas result from the refusion of preexisting rocks within a limited area. Indeed Becker discards altogether the doctrine of differentiation, and conceives the varied assemblage of rocks in a given province as produced by admixture from a certain number of primitive types. These, he says, should be recognizable by their wide distribution and constant character. It is clear, however, that, on the hypothesis of admixture, the primitive types must be those of extreme composition. These are, in fact, always the rarest and the most variable, pointing not to admixture, but to differentiation as the cause of the diversity. A theory which attributes the special characteristics of petrographical provinces to permanent heterogeneity in the composition of the globe is difficult to reconcile with the small extent and sharp definition of some strongly characterized provinces, such as that of Assynt or of the Bohemian Mittelgebirge. A more fatal objection is that petrographical provinces are not in fact permanent. A good illustration is afforded by the midland valley of Scotland, an area our knowledge of which has been much enlarged by the recent work of the Geological Survey. It was the theater of igneous activity in Lower Old Red Sandstone times and again in the Carboniferous, but, in respect of mineralogical and chemical composition, the two suites of rocks present a striking contrast. The Old Red Sandstone lavas are mostly andesites, though ranging from basalts, on the one hand, to rhyolites, on the other, and the associated intrusions are mainly of diorite, quartz diorite and granite, with porphyrites and other dyke-rocks. In the Carboniferous, on the other hand, we find porphyritic basalts, mugearites and trachytes (including phonolitic types), with picrites, teschenites, monchiquites, orthophyres and other allied rocks. It would be possible to cite many other cases illustrating the same point.

THE ALKALINE AND CALCIC BRANCHES

The two Scottish suites of Upper Paleozoic rocks just mentioned fall into opposite categories with reference to what is now becoming recognized as the most fundamental distinction to be made among igneous rocks. The earlier set is typical of the andesitic division and the later of the tephritic; or, using other equivalent names, the one belongs to the calcic (or "alkali-calcic") branch and the other to the alkaline. I will adopt the latter terminology as being generally familiar to petrologists; but the characteristics of the two branches, which are too well known to need recapitulation here, are more clearly definable in mineralogical than in chemical language. This two-fold division of igneous rocks is, of course, in no wise a final or exhaustive treatment of the subject; but as a first step towards a natural or genetic classification it seems to be established beyond question. No third branch in any degree comparable with the two and distinct from them has been proposed. The charnockites and their allies represent but a single rock-series, and Rosenbusch has not made clear his reasons for separating them from the calcic rocks.

The "spilitic" suite of Dewey and Flett is made to embrace a somewhat miscellaneous collection of types, and any close genetic relationship among them can scarcely be considered as proved. It is perhaps permissible to suggest that, *e. g.*, the quartz-diabases are, here as in Scotland, quite distinct in their affinities from the types rich in soda. These latter, constituting the bulk of the proposed suite, would seem to belong quite naturally to the alkaline branch, the question of the magmatic or solfataric origin of the albite being in this connection immaterial.

A given petrographical province is either of calcic or of alkaline facies, typical members of the two branches not being found together. The apparent exceptions are, I think, not such as to modify very seriously the general rule. Mr. Thomas, in describing an interesting suite of rocks from western Pembrokeshire, recognizes the alkaline affinities of most of them, but assigns some of the more basic types to the opposite branch. In a very varied assemblage we not infrequently meet with a few extreme types which, occurring in a calcic province, recall the characters of alkaline rocks, or conversely. Such anomalies have been pointed out by Daly, Whitman Cross, and others. They are found among the later derived types, referable to prolonged or repeated differentiation, and they are to be expected especially where the initial magma was not very strongly characterized as either calcic or alkaline.

Having regard to the known exposures of igneous rocks over the existing land-surface of the globe, it seems that there is a very decided preponderance of the calcic over the alkaline branch. This, as we shall see, is probably a fact of real significance, but it is nevertheless noticeable that increasing knowledge tends partly to redress the balance. In our own country, in addition to the Scottish Carboniferous rocks and those probably of Ordovician age in Pembrokeshire, we have the remarkable Lower Paleozoic intrusions of Assynt, in Sutherland, of strongly alkaline character, as described by Dr. Teall and more recently by Dr. Shand; while Dr. Flett has recognized alkaline rocks of more than one age in Cornwall and Devon, and Mr. Tyrrell is engaged in studying another interesting province, of Permian Age, in Ayrshire.

That the distinction between the alkaline and the calcic rocks embodies some principle of real and fundamental significance becomes very apparent when we look at the geographical distribution of the two branches. Taking what the German petrographers call the "younger" igneous rocks, *i. e.*, those belonging to the latest system of igneous activity, we find it possible to map out the active parts of the earth's crust into great continuous regions of alkaline rocks on the one hand and of calcic on the other. An alkaline region comprises numerous petrographical provinces, which may differ notably from one another, but agree in being all of alkaline facies. In like manner a common calcic facies unites other provinces, which collectively make up a continuous calcic region. Concerning the igneous rocks of earlier periods our knowledge is less complete, but, so far as it goes, it points to the same general conclusions.

These considerations enable us to simplify at the outset the problem before us. If we would seek the meaning and origin of petrographical provinces, we must inquire in the first place how igneous rocks, as a whole, come to group themselves under two great categories, which, at any one period of igneous activity, are found in separate regions of the earth's crust. The

fact that a given district may form part of a calcic province at one period and of an alkaline one at another, precludes the hypothesis that the composition of igneous rocks depends in any degree upon peculiarities inherent from the beginning in the subjacent crust. The same objection applies with scarcely less force to various conflicting suggestions based on an assumed absorption or "assimilation" of sedimentary rocks by igneous magmas. Thus Jensen supposes the alkaline rocks to be derived by the assimilation or fusion of alkaline sediments at great depths. Daly propounds the more elaborate, and on a first view paradoxical, theory that alkaline have been derived from calcic magmas as a consequence of the absorption of limestone. These geologists agree in regarding the alkaline rocks as relatively unimportant in their actual development and in some sense abnormal in their origin. For Suess, on the other hand, it is the calcic rocks which owe their distinctive characters to an absorption of sedimentary material, enriching the magma in lime and magnesia. Apart from difficulties of the physical and chemical kind, all such theories fail to satisfy, in that they ignore the separation of the two branches of igneous rocks in different regions of the globe, each of which includes sediments of every kind. What then is the real significance of this regional separation? The obvious way of approaching the question is to inquire first whether the alkaline and calcic regions of the globe present any notable differences of a kind other than petrographical.

RELATION BETWEEN TECTONIC AND PETROGRAPHICAL FACIES

The close connection between igneous activity and displacements of the earth's crust has been traced by Suess, Lossen, Bertrand, de Lapparent and others, and is a fact sufficiently well recognized. We have here indeed two different ways of relieving unequal stresses in the crust, and it is not surprising that they show a broad general coincidence both in space and in time. We can, however, go farther. Not only the distribution of igneous rocks in general, but the distribution of different kinds of rocks is seen to stand in unmistakable relation to the leading tectonic features of the globe. It is very noticeable that petrographical provinces, and in particular provinces belonging to opposite branches, are often divided by important orographic lines. This is illustrated by the Cordilleran chain in both North and South America, and again by some of the principal arcs of the Alpine system in Europe. If now we examine the actual distribution more closely, in the light of Suess's analysis of the continents and oceanic basins, we perceive another relation still more significant. It is that, as regards the younger igneous rocks, the main alkaline and calcic regions correspond with the areas characterized by the Atlantic and Pacific types of coast-line, respectively. I briefly drew attention to this correspondence in 1896, and a few years later Professor Becke, of Vienna, arrived independently at the same generalization. Recalling the two classes of crust-movements discriminated by Suess, he says it appears that the alkaline rocks are typically associated with subsidence due to radial contraction of the globe, and the calcic rocks with folding due to lateral compression. The greater part of Becke's memoir is devoted to a comparison of the two branches in respect of chemical composition; but here, I think, he has been misled by taking as representative of the whole alkaline "*Sippe*" or tribe the rocks of one small and peculiar province, that of the Bohemian Mittelgebirge. Some petrologists have followed Becke in adopting the

terms Atlantic and Pacific as names, or at least synonyms, for the two branches of igneous rocks. Others, perhaps with some justice, deprecate the use of the same terms in a petrographical as well as a tectonic sense, so long as the implied relationship is still a matter of discussion.

I would point out in passing that the association of the alkaline rocks with areas of subsidence helps to explain the relatively small part which they play in the visible portion of the earth's surface. We may not unreasonably conjecture, for instance, that the volcanic islands scattered sparingly over the face of the Atlantic Ocean, from the Azores to Tristan d'Acunha, are merely fragments of a very extensive tract of alkaline rocks now submerged.

The generalization associated with the name of Becke, in so far as it may ultimately commend itself to general acceptance, must have an important bearing on the problem of the origin of petrographical differences. The time is not ripe for any dogmatic pronouncement, but I will venture to indicate briefly the general trend of the inferences to be drawn. It seems clear that only a trivial effect at most can be allowed to original and permanent heterogeneity of the earth's crust, or to such accidents as the absorption by an igneous magma of a limited amount of the country-rock. The division between alkaline and calcic regions, and the separation of distinct provinces within such regions, point rather to the same general cause which, at a later stage, produced the diversity of rock-types within a single province, that is to magmatic differentiation. Here, however, the differentiation postulated must be on a very wide scale, and must take effect in the horizontal direction. Its close connection with crust-movements clearly indicates differential stress as an essential element in the process. The actual mechanism can be at present only a matter of speculation, but I think the clue will be found in such observations as those of Mr. Barrow on the pegmatites of the Scottish Highlands. Conceive an extensive tract to be underlain by a zone which is neither solid nor liquid, but composed of crystals with an interstitial fluid magma. If this be subjected to different pressures in different parts of its horizontal extent, its uniformity will necessarily be disturbed, the fluid portion being squeezed out at places of higher pressure and driven to places of lower pressure. The precise nature of the differentiation thus set up will depend on the relative compositions of the crystalline and fluid portions, and the subject could not be very profitably discussed without fuller knowledge concerning the order of crystallization in rock-magmas. Whether or not the explanation be ultimately found in this direction, the relation between the two tectonic types and the two branches of igneous rocks must, I think, find a place in the final solution of the problem.

I intimated at the outset that my remarks would not be confined to matters already settled and indisputable. It will be easily understood that some statements which I have made, for the sake of clearness, without qualification are subject to exceptions, and exceptions have, indeed, been urged by critics whose opinions are entitled to respect. The most uncompromising of these critics, Dr. Whitman Cross, has laid it down that: "Only generalizations without known exceptions in experience can be applied to the construction of a system that may be called natural." I hold, on the contrary, that such a science as geology can be advanced only by the inductive method, which implies provisional hypotheses and successive approximations

to the truth. A generalization which brings together a mass of scattered observations, and endows them with meaning, is not invalidated by the discovery of exceptions. These merely prove that it is not a final expression of the whole truth, and may point the way to its revision and correction.

Take, for instance, our provisional law of the distribution of the two branches of igneous rocks in defined regions. It has been objected that leucitic lavas, having therefore very decided alkaline or Atlantic affinities, are known at several places within the limits of the main Pacific region, where they are associated with andesitic and other calcic rocks. Now, the only area for which we have anything like full information is the island of Java. Here, according to Verbeek and Fennema, the great plateau-lavas of Tertiary age are exclusively of andesitic types, and the same is true of the long chain of 116 volcanic centers, which represent the later revival of activity. As against this record there are five volcanoes, long extinct, which at one stage erupted leucitic lavas. Whether we suppose these to be aberrant derivatives from an andesitic magma, or, much more probably, an incursion from the neighboring alkaline region, it seems reasonable to regard these very exceptional occurrences as of the second order of importance, and to set them aside in a first attempt to reduce the facts to order.

The discovery of various alkaline rocks on Hawaii, Samoa, Raratonga, Tahiti and other islands in the midst of the Pacific Ocean raises, I think, a different question. So far as is known, these rocks are not found in close association with characteristic calcic types. Suess's masterly discussion of all the geographical and hydrographical data hitherto obtained makes it clear that an Atlantic as well as a Pacific element of structure enters into some parts of the Pacific basin. In certain areas, such as the Galapagos Archipelago, the coming in of the Atlantic régime is quite clearly reflected in an alkaline facies of the igneous rocks, and such exceptions are therefore of the kind which go to prove the rule. Both Max Weber and Lacroix have expressed the opinion that the andesitic branch of rocks is characteristic of the border of the great Pacific basin rather than the interior. It is possible that further knowledge may justify this conclusion, and still only confirm the relation which is claimed between the two tectonic types and the two petrographical facies. Meanwhile we find clear evidence elsewhere that vertical subsidence and lateral thrust have sometimes occurred in the same region or in the same petrographical province; nor need we go far from home to learn that the complexity of structure thus implied is accompanied by a corresponding peculiarity of petrographical facies.

THE NORTH BRITISH TERTIARY PROVINCE

In order to illustrate this point in a concrete instance, I will discuss very briefly a single petrographical province, viz., that which occupied the northern part of Britain in early Tertiary times. Professor Judd has regarded this as forming part of a larger "Brito-Icelandic province"; but, while recognizing many affinities between our rocks and those of higher latitudes, I think that the North British area possesses enough individuality to be more properly treated as a distinct unit. The record of igneous action here is exceptionally complete and well displayed. Our knowledge of it is derived in the first place from Professor Zirkel, Sir Archibald Geikie and Professor Judd, and more recently from the detailed work carried out by the Geological Survey of Scotland. This latter is,

as regards the Isle of Mull, still in progress, and will doubtless when completed throw additional light on some questions still obscure.

The province includes all western and southern Scotland, with the northern part of Ireland, and extends southward as far as Anglesey and Yorkshire, but the chief theater of igneous activity was the sunken and faulted tract of the Inner Hebrides, between the mainland of Scotland, on the one hand, and the Archæan *massif* of the Outer Isles, on the other. It is here that the volcanic accumulations attain their greatest thickness, and here, closely set along a N.–S. line, are the plutonic centers of Skye, Rum, Ardnamurchan and Mull. Farther south are the volcanic plateau of Antrim and the neighboring plutonic centers of the Mourne Mountains and Carlingford, while the two centers of Arran and that of Ailsa lie on a parallel line only a little farther east. In addition it is clear that igneous activity extended westward over a tract now submerged under the Atlantic, and here too plutonic centers were not wanting. One is exposed in St. Kilda, 50 miles west of the Outer Hebrides, and another has been inferred by Professor Cole from a study of the stones dredged on the Porcupine Bank, 150 miles west of Ireland.

The connection of igneous action in this province with the subsidence of faulted blocks of country is too plain to be missed; and so far, excepting the tendency to a definite alignment of the foci of activity, we seem to be dealing with a typical example of the Atlantic régime. The actual tectonic relations are, however, of a more complex kind, and undoubtedly involve the element of lateral thrust as well as vertical subsidence. This is more particularly in the neighborhood of those special centers which were marked at one stage by plutonic intrusions. The evidence is seen in sharp anticlinal folding; sometimes also in crush-brecciation along quasi-horizontal bands and (in Rum) contemporaneous gneissic structure in the plutonic masses themselves. The disturbances in Mull, as described by Mr. Bailey, are especially interesting. The whole eastern coast-line of the island is determined by a system of concentric curved axes of folding, affecting all the rocks up to the Tertiary basalts, which are in places tilted almost vertically. The curved axes are disposed with reference to the plutonic center of the island, and a somewhat similar arrangement is found on the east side of the Skye center. All these facts go to show that in the district surrounding any one of the special centers there was developed a complex system of stresses, which found relief partly in igneous action, partly in displacements of the solid rocks. Nor were the effects confined to the plutonic phase. At a later epoch the influence of these local stresses is sometimes indicated by the diversion of the very numerous dykes from their normal northwesterly direction to a radial arrangement about the special centers, as is seen partly in Skye and more strikingly in Rum. There are also local groups of dykes developed only in these districts, and these again sometimes have a radial arrangement. More remarkable are the groups of inclined sheets which are found about the same centers, usually intersecting the plutonic rocks and a small fringing belt, and constantly dipping inwards. Such sheets occur in immense numbers in the gabbro mountains of Skye and Mull, and they are to be recognized also in Rum and Ardnamurchan.

It is plain then that this province exemplifies at once the two tectonic types distinguished by Suess. There has been a general subsidence, affecting the area as a

whole but not all parts equally, and with this we must connect those groups of igneous rocks which have a wide distribution throughout the province. But there have also been movements in the lateral sense, more strictly localized and more sharply accentuated, and to these belong evidently the plutonic rocks with various other groups which are their satellites. I have pointed out these facts elsewhere, but failed to follow out the logical conclusions on the petrographical side. Influenced by the strongly marked characters of the plutonic series, I assigned the North British Tertiary rocks, not without some misgivings, to the calcic or Pacific region. Suess, having regard probably to the broader tectonic features rather than to petrographical data, has included our area in the Atlantic region.

Concerning the calcic facies of the plutonic rocks there can be no question. They constitute a well-defined "rock-series," intruded in order of decreasing basicity, and ranging from ultrabasic to thoroughly acid. The ultrabasic rocks, as developed in Rum and Skye, have a lime-felspar as one of their chief components: there are no picrites (in the original sense of Tschermak) or other alkaline types. The eucrite group, found in Rum, Ardnamurchan and the Carlingford district, is also characterized by a felspar near anorthite. Gabbros are represented at nearly all the several centers, and in Arran they are accompanied by norites. The granites and granophyres fall into two sub-groups. The less acid is usually augitic, while the more acid, found in Arran, St. Kilda and the Mourne Mountains, carries hornblende and sometimes biotite.

This series is known in various provinces of Pacific facies. A peculiarity of it is that it is a broken series, types of mean acidity being absent. This has an interesting consequence. In many places a granite magma, invading rocks so different from itself as gabbro or eucrite, has caused energetic mutual reactions, and a set of hybrid rocks has been produced, which serves in a limited sense to fill the gap in the series.

The only known exceptions to the calcic facies of our Tertiary plutonic rocks are perhaps significant in that they occur near the northern and southern limits of the principal belt of activity. The massive gently inclined sheets of granite and granophyre which make up part of the southern end of Raasay consist largely of microperthite, and contain abundant riebeckite, a distinctively alkaline mineral known at only one spot in Skye. The microperthitic granites of Arran do not carry riebeckite, but it is found in the well-known rock of Ailsa Craig, farther south.

The local groups of minor intrusions—acid, basic and ultrabasic—related to the several plutonic centers have the same calcic facies as the plutonic rocks of which they are satellites. It appears, however, that they sometimes tend to a more alkaline composition towards the borders of their respective districts. Thus, the Skye granite is surrounded by a roughly oval area, within which are found numerous dykes and sills of felsite and granophyre, in general augitic; but on the fringe of the area these rocks give place to orthophyres, with biotite or hornblende, and to bostonites.

Turn now to the rocks of regional distribution. The most important are, of course, the basalt lavas. They are all felspar-basalts, but a very general feature is the filling of their numerous amygdaloidal cavities with zeolites, such as analcime, natrolite, chabazite and stilbite. These minerals are certainly not mere weathering-products. When I examined the ba-

salts of Skye and the Small Isles some years ago, I regarded the zeolites as solfataric products, formed at the expense of the felspar by the action of volcanic water, while the rocks were still at a somewhat high temperature. Subsequent reconsideration has led me to consider these minerals rather as primary constituents of the rock, crystallized directly from the final residual magma, which had become relatively enriched in water by the abstraction of the anhydrous minerals. Such was the conclusion reached by Mr. James Strachan for the Antrim basalts, and a study of examples from Mull and Skye has enabled me to confirm and extend his interesting observations. Analcime in particular is not always confined to the steam-cavities, but in some cases occurs interstitially in the rock, where it is certainly not derived from felspar, and, indeed, has all the appearance of a primary constituent. The augite of these analcime-bearing basalts has in thin slices a purplish tint, with sensible pleochroism. From these and other features it appears that this group of rocks reveals on examination decided, though not very strongly marked, alkaline affinities.

Volcanic rocks of other than basaltic composition are not largely developed. They include both rhyolites and trachytes, the former without very distinctive characters, but the latter falling naturally into the alkaline division. In describing formerly a group of rhyolites and trachytes on the northern border of the Cuillins, I connected it with the neighboring plutonic center, but I have since found other trachytes in Skye: there is a fine development exposed in the glen above Bracadale. From this, and from the situation of the Antrim rhyolites, I infer that these felspathic and acid lavas, though distributed sporadically, belong to the regional or Atlantic suite.

Consider next the wide-spread group of basic sills. The common non-porphyritic dolerite sills have, in most districts, little that is indicative of alkaline affinities, though chemical analyses show a rather noteworthy amount of soda. In the porphyritic dolerites this characteristic is much more apparent, and indeed these rocks are almost identical with the "Markle type" so largely represented among the alkaline rocks of the Scottish Carboniferous province. Mugearite, a type still richer in alkalies, is likewise common to the two provinces. As we approach the limits of the principal belt of activity, alkaline characteristics become well marked even in the common non-porphyritic dolerites. This is shown in Raasay and the northern part of Skye by the coming in of the purple pleochroic augite, while farther north, in the Shiant Isles, analcime enters and even, according to a record of Heddle, nepheline.[2] At the other extreme, in southern Arran, occur the analcime-dolerite sills of Clauchland and Dippin.

The regional basic dykes, which are mostly posterior in age to the sills, exhibit more variety of composition. Some with abundant porphyritic felspars resemble the Markle type of dolerite, and there are others of mugearitic nature, but these are only a minority. In Argyllshire there are basic dykes with purple pleochroic augite, and even some of camptonite and monchiquite; but these latter at least I should exclude as being probably of late Paleozoic age.[3] The undoubtedly Tertiary dykes, however, exhibit a variety which can be

[2] The dolerite here is intimately associated with ultra-basic rocks, as has been described by Judd.

[3] A like remark applies to the highly alkaline dykes of the Orkneys, which do not agree even in direction with the Tertiary suite.

explained only as the result of repeated differentiation. The distribution of some of the groups indicates the existence at this late stage of subsidiary centers of differentiation, distinct from the plutonic centers. Thus, trachyte dykes are found especially throughout a tract extending from the southwestern part of Skye through the middle of Argyllshire, while there is an isolated area of these dykes about Drynoch, on the opposite side of the Skye mountains. Here we have an evidently alkaline type. On the other hand, there are rocks which, taken by themselves, must be assigned to the calcic division. Augite-andesites, for example, are well known, especially in parts of western Argyllshire, in Arran and the Cumbraes, and in the outlying districts of the north of Ireland, Anglesey and the northeast of England. That these rocks have arisen as products of a subsidiary differentiation, we have in some cases almost ocular demonstration; for in Arran and elsewhere augite-andesites are found in remarkably intimate association with complementary types, often pitchstones of alkaline composition.

Even from so brief and imperfect a sketch we may, I think, draw some conclusions which have a wider application. This province exemplifies at once the two main tectonic types, and also comprises representatives of the two great branches of igneous rocks. Those rocks which are related to broad movements of Atlantic type indicate a parent magma of decided, though not strongly marked, alkaline nature; while those related to local movements of Pacific type clearly come from a calcic magma. There are some facts which suggest that the rocks tend to become more alkaline as we recede from the chief centers of activity, and this suggestion applies to some calcic as well as alkaline groups of rocks. Finally, it appears that the relative simplicity of arrangement was disturbed at a late stage by the effects of subsidiary differentiation, the province tending then to break up into districts related to new centers. Operating upon an initial magma not very strongly characterized, this later differentiation has even given rise to aberrant rock-types which overstep the petrographical boundary line between the two branches.

PETROGENESIS AND SYSTEMATIC PETROGRAPHY

From such considerations as I have hastily passed in review, it is evident that a survey of igneous rocks as they actually occur in the field leads to a conception of their mutual relationships very different from that embodied in the current schemes of systematic petrography. It may be of some interest, in conclusion, to expand this remark a little farther, although I am sensible that in so doing I lay myself open to the charge of vain speculation.

From the petrogenetic point of view, the most fundamental division among igneous rocks is that between the alkaline and calcic branches. This result, independently arrived at on petrographical grounds by several authorities, seems to be firmly established by the broad distribution of the two branches in different regions of the globe. But, if this argument be admitted, it follows that the next step in a natural grouping of igneous rocks should be suggested by a comparison of the characteristics of the various provinces into which the great regions divide. Many of these provinces have now been partly studied, and their special characteristics can often be expressed in concise terms: *e. g.*, among alkaline rocks the relative proportion of potash to soda may be a characteristic common to a whole province. More precisely, by averaging the chemical analyses of the chief rock-types, weighted according to

their relative abundance, it is possible to calculate approximately the composition of the parent-magma of a province. Noting that nearly identical assemblages of rocks sometimes occur in widely separate provinces and at different geological periods, we have some reason for expecting that the provincial parent-magmas may ultimately be reduced to a limited number of types. Whether these types will be sufficiently definite to serve as a basis of classification it is too early to say.

For the sake of argument, I have taken chemical composition as the criterion. It is certain, however, that a rock-magma consists, not of free oxides, but mainly of silicate-compounds, and the variation produced by magmatic differentiation is a variation in the relative proportions of such compounds. The characteristics common to a set of cognate rock-types will, therefore, be more properly expressed in mineralogical than in chemical terms. If, to fix ideas, we take as representative of a province its principal plutonic series, we shall often find that some particular mineral or some special association of minerals stands out as a distinctive feature. For instance, in the charnockite-norite series of southern India the characteristic ferro-magnesian mineral is hypersthene; in the granite-gabbro series of the British Tertiary it is augite; and in the granite-diorite series, which predominates among the "newer granites" of the Scottish Highlands, hornblende and biotite. These three sets of rocks, all of calcic facies, are easily distinguishable in isolated specimens.

Each such rock-series embraces types ranging from acid to ultrabasic. This variation is ascribed to a later differentiation of the parent-magma of the province, and, therefore, in an arrangement based on genetic principles, it will find expression, not in the main divisions of the scheme, but in the subdivisions. Here is an essential difference between an ideal petrogenetic classification and the petrographical systems which are, or have been, in use. If we are content to limit our study of igneous rocks to specimens in a museum, the distinction of acid, neutral, basic and ultrabasic may seem to be of first importance. It has, in fact, been employed for the primary divisions in some formal schemes, *e. g.*, in that put forward by Löwinson-Lessing. In a less crude system, like that of Rosenbusch, this element disappears, but the underlying idea still remains. There is a division into families, such as the granite-family and the gabbro-family, but the term, in so far as it implies blood relationship, is a misnomer. The augite-granite of Mull is evidently more closely related to its associated gabbro than it is, say, to the biotite-granite of Peterhead or the hypersthene-granite of Madras.

The differentiation which evolves a varied series of plutonic rocks from a common parent-magma is clearly not of the same kind as that which gave rise to the parent-magma itself. It appears that the external mechanical element is here a less important factor, and the variation set up is, therefore, more closely in accordance with the uninterrupted course of crystallization. This is clearly indicated when we compare the order of intrusion of the several rocks of the series with the order of crystallization of their constituent minerals. The history of the series is in a sense epitomized in the history of each individual type, corresponding in both cases with continued fall of temperature and progressive change in the composition of the residual magma. In a large number of rocks, more particularly those of complex constitution, the order of crystallization follows Rosenbusch's empirical law of decreasing

basicity, and the plutonic intrusions then begin with the most basic type and end with the most acid. I mention this only to point out that, while the larger divisions of our ideal classification will have a certain geographical and tectonic significance, the subdivisions will show a certain correspondence with the sequence in time of the various cognate rock-types.

To pursue the subject farther would serve no useful purpose. It is clear that, if a natural—by which I mean a genetic—classification of igneous rocks is ever to become a reality, much work must first be done, both in the field and in the laboratory, each petrographical province being studied from the definite standpoint of the evolution of its rock-types from one parent stock. Such researches as those of Brögger in the Christiania province may serve as a model. It would be rash to venture at present more than the most general forecast of the lines which future developments may follow; but I think it calls for no less hardihood to set limits to what may ultimately be possible in this direction. There are those who would have us abandon in despair all endeavor to place petrography upon a genetic basis, and fall back upon a rigid arbitrary system as a final solution of the difficulty. This would be to renounce forever the claim of this branch of geology to rank as a rational science. I have said enough to show that I am one of those who take a more hopeful view of the future of petrology, confidently expecting it to show, like the past, a record of continued progress.

ALFRED HARKER

LETTER TO THE SECRETARY OF AGRICULTURE DISMISSING THE CHARGES AGAINST OFFICERS OF THE BUREAU OF CHEMISTRY

I RETURN herewith the papers which you have submitted to me in the matter of the report of the Committee on Personnel of the Department of Agriculture, in which, after summarizing the evidence adduced before them, they recommended that Dr. H. H. Rusby, pharmacognosist in the Bureau of Chemistry, be dismissed from the service; that Dr. L. F. Kebler, chief of the drug laboratory in the Bureau of Chemistry, be reduced from his present position, and Dr. H. W. Wiley, chief of the Bureau of Chemistry, and Dr. W. D. Bigelow, assistant chief of the bureau, be given an opportunity to resign from the positions which they now hold in the Bureau of Chemistry, on account of the irregularities in the appointment of Dr. H. H. Rusby.

The facts shown by the papers, stated shortly, are as follows:

Dr. Rusby lived in New York, and was employed as a scientific expert in the Bureau of Chemistry to examine importation of drugs, under an agreement by which he received $20 a day for laboratory work and $50 a day for attendance in court.

On May 24, 1909, the Attorney-General advised the Secretary of Agriculture that, under the act of March 4, 1907 (34 Stat. 1289), no classified scientific investigator should receive a salary to exceed $9 a day. On May 29, 1909, an order was issued putting him on the roll at a salary of $9 a day when actually employed. Dr. Rusby objected to this, and applied to Dr. Kebler, chief of the drug laboratory, to secure a different arrangement. The matter seems to have been held in abeyance for some time. Finally, as a result of conference between Dr. Kebler, Dr. Bigelow and Dr. Wiley with respect to the request of Dr. Rusby for an increased compensation, Dr. Wiley said he would submit to you for your approval an appointment of Dr. Rusby at a salary at the rate of $2,000 per annum on the miscellaneous roll. Dr. Bigelow then wrote to Dr. Rusby, under date of January 2, 1910, as follows:

> Dr. Kebler and I took the matter up with Dr. Wiley to-day, and he said he would approve it if we had on record an understanding with you, so we could not be held responsible for your receiving

an annual salary and not devoting your whole time to the bureau. I told him that if you were given an appointment at the rate of $170 a month, you would agree not to receive more than $20 a day for time actually employed. By that I mean the usual official day of seven and one half hours. This would be equivalent to eight and one half days a month on the average. I told him that if it happened that your work for the department amounted on the average to less time than that you would ask for leave of absence for sufficient time to bring it to that basis.

Dr. Rusby answered this letter and questioned what was meant by it. He said he did not understand Bigelow's letter clearly and supposed that if he did not earn the entire salary, he would not expect to receive any more than was earned.

Meantime, on February 6, Dr. Wiley submitted to you an appointment of Dr. Rusby at a salary at the rate of $1,600 per annum on the miscellaneous roll. He made the reduction after examining the records and finding the amount of work done by Dr. Rusby during the preceding two years. You approved this appointment.

After the appointment Dr. Bigelow wrote Dr. Rusby that he thought the present arrangement was better than the former arrangement when he was receiving $20 per day for laboratory work, and $50 a day for court work, because, he said, "you are now assured of getting a certain amount each month, irrespective of the time spent, and you can still so plan your work as to interfere with your regular duties to a minimum extent."

This did not satisfy Dr. Rusby, and he sought further information in a letter dated March 3, 1911, as follows:

Kindly recall that on my side the basis of compensation is not less than $20 per day. At that rate only eighty days' work per year are provided for, and that is not time enough to satisfactorily perform more than the current port work here, leaving no time for examination of interstate samples, especially microscopical examinations, or for attendance at court. For every day at court, on the average, one day of preparation is required.

The above facts lead to the inquiry, would not the salary named compel me to either do very much more than eighty days' work per year or otherwise fail to do the necessary amount of work in a satisfactory manner?

On March 4 Dr. Kebler wrote to Dr. Rusby, stating among other things the following:

Personally I am of the opinion that your new appointment is much better than the old. Under this appointment you can do as little as one day's work per month, and you get your salary. On the other hand, if you work five or ten days, your salary would be the same per month. It seems to me that you have the matter largely in your own hands. I am satisfied that if you do not accept the new appointment nothing more can be done and your services, so far as our work is concerned, can no longer be utilized materially in the future.

On March 6 Dr. Rusby wrote to Dr. Kebler saying that he had decided to accept the appointment.

The nub of the charge by the Personnel Board was that Dr. Wiley, Dr. Kebler Dr. Bigelow and Dr. Rusby in effect conspired to put on the record a contract for a general employment of Dr. Rusby's services for $1,600 a year, but actually and secretly made a contract with him by which he was only to do enough work during the year for the $1,600 to secure him a compensation of $20 a day, and that this was done in deliberate and defiant violation of the law as interpreted by the Attorney-General in the opinion already referred to, in which he held that congress had limited the compensation of experts to $9 a day.

After you submitted to me the report of the Personnel Board, I asked the Attorney General to examine it and give me his opinion in respect to the matter, because it concerned the violation of the law as interpreted by him in one of his opinions. He did so, and advised me that the recommendations of the Personnel Board ought to be carried out. In connection with his recommendations he invited attention to a clause in the Act of Congress approved March 15, 1898 (30 Stat. L, 316), still in force, that enjoins upon the head of each department the duty of exacting from the employees in that department who are

under an annual salary labor amounting to seven hours every day but a holiday.

An examination of the records satisfied me that the questions had not been presented to the persons involved in such a way as to enable them to make full defence. They had only been called as witnesses and cross-examined without a full understanding that they were under trial which might involve their dismissal. Accordingly, I directed you to submit the whole record, together with the opinion of the Attorney-General, to each one of the persons charged, and invite from him an answer. These answers were filed in due course, and are quite full in detail. The answer of Dr. Wiley specifically denies that he ever saw the correspondence between Dr. Kebler and Dr. Rusby, or that he ever consciously entered into an arrangement by which Dr. Rusby was in effect to receive compensation at a rate in excess of that prescribed by the statute as interpreted by the Attorney-General. The truth is, it appears from the answers of Dr. Wiley, Dr. Kebler and Dr. Bigelow, that there had been a good many precedents in the department which seemed to justify the employment of Dr. Rusby at an annual salary, when it was not expected that his entire time would be taken up. This was the case with respect to the employment of what was known as the Remsen Board. That board was created by order of President Roosevelt for the very important purpose of enabling the Secretary of Agriculture to have reviewed the decisions of the Bureau of Chemistry in cases where those decisions involved disputed technical questions, and would, if sustained, have destroyed valuable and profitable business theretofore regarded as lawful. In such cases it was deemed wise not to allow the destruction of what would be otherwise lawful property and business on the decision of only one expert or the head of the bureau. Accordingly, the Remsen Board was created, and is composed of experts, all of whom were known to be engaged in other professional work than that of the reviewing board. Dr. Remsen, the head of the board, occupies an important position in Johns Hopkins University, and that is his principal occupation. Another member, Dr. Russell Chittenden, of the Sheffield Scientific School, is dean of that school, and that is his chief vocation. Hence, the employment of the Remsen Board at the rate of $2,000 a year for each member necessarily involved the proposition that such an annual salary might lawfully be paid without requiring labor of seven hours a day from each person so employed. This the Attorney-General in his opinion intimates is contrary to the statute, but in the Agricultural Department it was not thought to be the case. Solicitor McCabe, to whom I referred the question of precedents made in the case, replied that in the practise of the department the clause in the appropriation act of March 15, 1898, had been held to have no application to the employment of experts outside of Washington.

It is necessary fully to understand this difference between the attitude of the department toward an employment at an annual salary of this kind and the opinion of the Attorney-General in this matter, because if Dr. Wiley and his associates had understoood that the $1,600 annual salary required them to exact from Dr. Rusby seven hours a day for all the work days of the year, then of course his employment must have been known by them to be illegal and under the circumstances to be only a cover for a different contract of employment; but if they understood, as seems to have been the case generally in the agricultural department, that such an employment at an annual salary might be entered into with experts of this kind, and only subject the experts to an obligation to work for the department whenever called upon, with the understanding that they had some other vocation to which their chief attention was given, it clearly reconciled the action of Dr. Wiley with a desire to comply with the law. The recommendation of the Attorney-General given to me was upon only part of the evidence, and hence his judgment was different, doubtless from what it would have been if

he had had the whole record before him, as I have now. It seems fairly clear that Dr. Wiley, after an examination of the records concluded that the employment of Dr. Rusby at $9 a day for laboratory work and $50 a day for court work would amount to $1,600 a year if the department called on him whenever they needed him, and that it was this arrangement to which you consented. In Dr. Kebler's anxiety to induce Dr. Rusby to accept the new terms of employment he certainly betrayed a willingness to construe the contract of employment of Dr. Rusby at $1,600 a year in one way to reconcile it with the law, and in another way to satisfy Dr. Rusby in his wish to secure $20 a day, and I think he ought to be reprimanded for his disingenuous conduct in writing such letters as he did. He said that he did not intend to violate the statute as interpreted by the Attorney-General, and indeed that he did not know exactly what the ruling was; but whether he did or not, the language of his letters does not have a commendable tone and suggests a willingness to resort to evasion that calls for official reproof.

In respect to Dr. Rusby I do not find that he was advised at all as to the legal difficulty, and that he was only seeking for additional compensation which he thought to be adequate.

The truth is, the limitations upon bureau chiefs and heads of departments to exact per diem compensations for the employment of experts in such cases as this is a doubtful legislative policy. Here is the pure food act, which it is of the highest importance to enforce and in respect to which the interests opposed to its enforcement are likely to have all the money at their command needed to secure the most effective expert evidence. The government ought not to be at a disadvantage in this regard, and one can not withhold one's sympathy with an earnest effort by Dr. Wiley to pay proper compensation and secure expert assistance in the enforcement of so important a statute, certainly in the beginning when the questions arising under it are of capital importance to the public.

If this were a knowing, wilful, deliberate effort to evade the statute as construed by the Attorney General, accompanied by a scheme to conceal the evasion and violation, I should think the punishment recommended by the personnel board, and concurred in by the Attorney-General, was none too great; but an examination of the whole case satisfies me that a different construction ought to be put upon what was done; that the evidence does not show that Dr. Wiley was a party to the correspondence or the letters upon which the chief charge is founded, and that his action in the matter was only in accord with previous precedents in the department which justified him in doing what he did.

With respect to the other persons charged, I find an overzeal in Dr. Kebler and Dr. Bigelow which prompted a disingenuous method of squaring Dr. Rusby's desire for what he thought was adequate compensation with the contract which you and Dr. Wiley were willing to make with him and that for this Dr. Kebler and Dr. Bigelow should be reprimanded by you. So far as Dr. Rusby is concerned, with respect to this particular contract, I do not find him at fault. For purposes of punishment or dismissal, I can not charge him with knowledge of the legal difficulties involved in his employment.

I examined the record in this case a number of weeks ago and reached the conclusion which I have stated here; but meantime, a committee of the House of Representatives deemed it proper to institute an investigation into the Department of Agriculture, and especially into the Bureau of Chemistry and its relation to the department generally.

It seemed to me under these conditions that perhaps it was wiser for me to delay until the investigation was completed and the report of the committee made. The committee has not made a report, although I believe the evidence has been substantially closed, and will not do so until the next session of congress. Further consideration satisfies me that there

are very much broader questions involved in the investigation and the evidence there brought out than in the present charge which is narrower and definite and can now be properly disposed of. The broader issues raised by the investigation, which have a much weightier relation than this one to the general efficiency of the department, may require much more radical action than the question I have here considered and decided.

There is another charge against Dr. Rusby for securing the appointment on the common laborers rolls, of a physician and expert, whom he could use to do his work at a very small stipend when he himself was called away in other employment. I regret to say that the arrangement which Dr. Rusby thus made is not especially creditable to him and shakes in some degree one's confidence in his avowed wish to make personal pecuniary sacrifice in the public interest for the enforcement of the pure food law. But Dr. Rusby's position as an expert of high standing is such that I do not think that any more than this expression of opinion should be imposed as penalty. My information is that the government needs his services and that he has already rendered valuable aid. The error referred to, committed by him, does not call for further action or remark.

You will communicate the result to the Personnel Board, and also to the persons charged.

Sincerely yours,

WILLIAM H. TAFT

PROFESSOR JOSIAH KEEP

PROFESSOR KEEP, whose death, on July 27 last, at Pacific Grove, California, was recently announced, was born in Paxton, Mass., in 1849, and was a graduate of Leicester Academy and Amherst College (1874), taking his Master's degree as a post-graduate student in 1877. In that year he married Amelia Caroline Holman, of Leicester, Mass., and went to California. There he taught in the Golden Gate Academy and the Alameda High School, being principal of the latter from 1881 to 1885. In 1885 he became Professor of the Natural Sciences in Mills College, which, from small beginnings as a private seminary for girls, has through the efforts and generosity of its founders developed into a well-equipped and charmingly situated college, the Wellesley of the Pacific Coast.

Here Professor Keep found his life work as teacher and coadjutor with the still surviving founder, Mrs. Mills, and saw the branches of science originally confided to him alone, by degree represented in the teaching force by a number of competent instructors, while he retained for himself the subjects of geology and astronomy.

With the wide general knowledge required by his field of work, it was of course impossible for him to be a specialist in any, but his deep interest had been aroused in the study of the mollusca in which the Pacific Coast is so rich. Between 1881 and 1911 he published a series of what might be called primers of west-coast shells, illustrated with figures, enabling the beginner to gain a preliminary knowledge of the attractive shells of California. To these little books we may fairly ascribe much of the wide-spread interest which is to-day found among Californians and which by the cooperation of amateurs with specialists, has immensely increased our knowledge of the Pacific coast fauna.

The last of these manuals was published only shortly before his death. Professor Keep was one of the founders of the Chautauqua Assembly which meets at Pacific Grove, and frequently lectured to its classes on his favorite subject. He was also one of the most earnest supporters of the Museum and Library at Pacific Grove.

Modest, courteous, indefatigable and enthusiastic, he was primarily a teacher and organizer; beloved by his classes and appreciated by those reached through his books and so led to the study of nature. In his unassuming way he has done a good work and found his reward in doing it. He leaves a widow, son and daughter to mourn his loss.

WM. H. DALL

A NEW NATIONAL MATHEMATICAL SOCIETY

Each of the five leading mathematical countries of the world—Germany, France, Italy, England and America—has a flourishing national mathematical society. In England and in Italy these societies still bear local names, while in America the name was changed from New York to American several years after the organization of the society.

Although the oldest of these societies, the London Mathematical Society, was organized a little less than half a century ago, they have developed at a marvelous rate during the last few decades and they play a prominent rôle in the present mathematical activity. At least two of them, the German and the Italian, are rapidly assuming an international character. In fact, considerably more than a hundred Americans are now members of the Italian society, while the German society has about eighty such members.

A Spanish Mathematical Society was organized at the University of Madrid during a session held on the fifth day of last April. Whether this new national society will assume a prominent place among those named above, remains to be seen. It has comprehensive plans with a view to uniting the Spanish mathematicians, and its development will be watched with unusual interest by Americans, since the Spanish language is used so extensively on our continent.

During the month following its organization the Spanish Mathematical Society began the publication of a monthly periodical bearing the name *Revista de la Sociedad Matemática Española.* Judging from the title page, it is to be very comprehensive, including articles on analysis, geometry, mechanics, astronomy, mathematical physics, geodesy, history, pedagogy, etc. The material appears under seven sectional headings bearing the following names: biography, doctrine, bibliography, news, vocabulary, intermedium, problems.

The society aims to publish translations of important foreign publications and to furnish these to its members at cost or even at a lower price. It also undertakes to look up references for its members and to furnish them with translations of journal articles at cost. The administrative office of the society is at 51 San Bernardo, Madrid, Spain, and the comprehensive plans of organization include a division of its members into nine different classes.

The first two numbers of the *Revista* have appeared and are very creditable in view of the general aims of the society. They contain 40 and 36 pages, respectively. The articles are brief and elementary, and comparatively few references are given. One could scarcely expect much in the way of profound scholarship in the early numbers of such a journal, as its main function is to awaken a mathematical interest and to reach many whom it can lead to higher planes and unite into a strong force.

Not all scientific men realize the urgent demands for wise labors in mathematical fields. In a recent number of the *Archiv der Mathematik und Physik,* volume 18, page 175, Professor Study makes the following observations: "As far as our geometrical production has any claims on earnest appreciation it is preponderantly careless work (Raubban). The success of Steiner and others with more or less natural talents seems to have aided to create a method, which is convenient, for both the author and the reviewer, of arriving at a verdict; according to this method only the *main facts* are considered in geometry, while precision is not regarded as a main fact." Professor Study goes on to point out that a great part of advanced geometry is now in the state of an undigested mass, and that it will require much additional work before all the matter which appears in Bianchi's classic "Lezioni di Geometria Differenziale" can be presented in a satisfactory manner.

While a considerable part of mathematics demands a re-working from the standpoint of precision, the numerous new fields that have been opened call continually for workers who are properly equipped. The increasing number of mathematical investigators calls for increasing supervision and direction, and

these can be most effectively furnished by mathematical societies. The new Spanish society has an unusually large amount of virgin soil, and the very rapid recent mathematical advances of Italy may inspire the hope that "nascitur non fit" may be applicable to this new society, and that it may have a healthy and rapid growth.

G. A. MILLER

AGRICULTURAL RESEARCH IN GREAT BRITAIN[1]

THE British Board of Agriculture and Fisheries has been in communication with the Development Commissioners with a view to the formulation of a scheme for the promotion of agricultural research and local investigations in England and Wales, and the treasury, on the recommendation of the commissioners, has sanctioned the allocation of funds to be distributed by the board in accordance with the general principles set out below. The total maximum sum which will be expended when the scheme is in full operation will be about £50,000 per annum.

The scheme provides for: (1) A system of agricultural research which will secure for each group of the problems affecting rural industry a share of attention roughly proportional to its economic importance. (2) The concentration of the scientific work on each group at one institution or at institutions working in combination. (3) Grants for special investigations for which provision may not otherwise be made. (4) The grant of scholarships with a view to the increase of the number of men fully qualified to undertake agricultural research. (5) The carrying out of investigations into problems of local importance, especially those involving the application of modern research to local practise, and the provision of scientific advice for farmers on important technical questions.

In making arrangements for the separate investigation, as far as possible, of each group of allied subjects the commissioners and the board have been impressed with the importance of securing continuity in work which is necessarily of considerable duration, and at the same time of providing staffs of specialists and experts who will be permanently engaged on work arising from the investigation of the same group of problems. By this means concentration and economy of effort will be better secured than it would be if a number of institutions were dealing at the same time with the same group of problems.

It is neither desirable nor possible to prevent all overlapping or duplication of work, but it is obviously necessary to proceed on a plan by which research work subsidized from public funds will not be unnecessarily duplicated. It is also desirable to arrange that each problem shall be undertaken by the institution best fitted to deal with it, and usually by the institution which has specially devoted its attention to problems of an allied nature. It is also important to avoid the giving of undue attention to one part of the field of agricultural research, to the exclusion of other parts which are of equal scientific and economic importance.

With these considerations in view, it has been arranged that grants should be made for research in the following groups of subjects: (1) plant physiology; (2) plant pathology and mycology; (3) plant breeding; (4) fruit growing, including the practical treatment of plant diseases; (5) plant nutrition and soil problems; (6) animal nutrition; (7) animal breeding; (8) animal pathology; (9) dairying; (10) agricultural zoology; (11) economics of agriculture.

[1] From the London *Times*.

THE AMERICAN MINING CONGRESS

THE fourteenth annual session of the American Mining Congress will be held at the Hotel La Salle, Chicago, Ill., October 24, 25, 26, 27 and 28. The original intention was to have the convention September 26 to 29. President Taft, however, found it would be impossible for him to attend and there arose the possibility that neither Secretary Fisher nor Director Holmes, of the Bureau of Mines, would reach Chicago by that date. The Alaska branch of the congress asked for a

postponement that they might send to the meeting a strong and representative delegation.

President Taft now heads the list of speakers and will address the congress on October 28, on the last day of the convention. Thus given an opportunity to obtain a general idea of the problem confronting the coal, metal and mining men from the speakers who have preceded him, he will be enabled to clearly outline the views of the administration on the various points at issue. The first public statement of the conclusions reached by Secretary Fisher as a result of his Alaskan trip will probably be made at this meeting. Director Holmes, of the Bureau of Mines, will deliver an illustrated address on "Coal Problems." Martin D. Foster, chairman of the house committee on mines and mining, will tell of the "Relation of Congress to the Mining Industry." President B. F. Bush, of the Missouri Pacific Railroad, will present a statement containing revelations of the present conditions of the coal industry, which will be a surprise even to many coal operators.

Governors Spry, of Utah, Carey, of Wyoming, Hawley, of Idaho, and Sloan, of Arizona, supported by a number of other western executives, will lead the discussions of the "Public Lands Questions of the West." They will come to the convention supported by strong contingents of delegates from west of the Mississippi and their views will be defined in no uncertain terms.

In addition to taking up the questions of policy for the opening up of Alaska and the public lands of the west, the general problems of the bituminous coal mining industry as intensified by the demand for better protection to miners and the conservation of fuel resources, will be another of the important issues considered. Of equal interest will be the discussions concerning workmen's compensation for the victims of mining accidents; the prevention of mining accidents; the prevention of waste of the natural resources and the conservation of the energy which now contributes to coal production.

HONORARY DEGREES AT THE UNIVERSITY OF ST. ANDREWS

THE senatus academicus of the University of St. Andrews has resolved to confer a large number of honorary degrees at the graduation ceremonial to be held in connection with the celebration in September of the 500th anniversary of the foundation of the university. The doctorate of laws will be conferred on the following men of science:

Allbutt, Sir Thomas Clifford, Regius professor of physic, University of Cambridge.

Barlow, Sir Thomas (president and delegate, Royal College of Physicians, London).

Berry, George Andreas, hon. surgical oculist to H.M. in Scotland (delegate, Royal College of Surgeons, Edinburgh).

Borgman, Ivan Ivan, professor of physics (delegate, Imperial University of St. Petersburg).

Bramwell, Byrom, president Royal College of Physicians, Edinburgh (delegate, Royal College of Physicians, Edinburgh).

Brown, Alexander Crum, former professor of chemistry, Edinburgh University (delegate, Royal Society of Edinburgh).

Burbury, Samuel Hawksley, F.R.S., London.

Cameron, Sir Hector Clare, professor of clinical surgery in the University of Glasgow.

Caullery, Maurice Jules Gaston Corneille, professeur de la chaire d'evolution des êtres organisés (delegate, University of Paris).

Gotch, Francis, F.R.S., Waynflete professor of physiology, University of Oxford.

Graff von Pancsova, Ludwig B., professor of zoology (delegate, University of Graz).

Holst, Peter Fredrik, professor of pathology, University of Christiania (delegate, University of Christiania).

Horne, John, F.R.S., director of Geological Survey for Scotland.

Keen, William Williams, professor of surgery, Jefferson Medical College, Philadelphia.

Lagerheim, Nils Gustaf, professor of botany, University of Stockholm (delegate, University of Stockholm).

Lamb, Horace, F.R.S., professor of mathematics, University of Manchester.

Larmor, Sir Joseph, F.R.S., Lucasian professor of mathematics, University of Cambridge, secretary of the Royal Society (delegate, Royal Society).

Meldola, Raphael, F.R.S., professor of chemistry in Finsbury Technical College (City and Guilds of London Institute).

Minot, Charles Sedgwick, professor of histology and human embryology, Harvard Medical School, Boston.

Mittag-Leffler, Gosta, professor of mathematics, University of Stockholm, Djursholm u. Stockholm, Rosenbad, 2.

Nathorst, Alfred Gabriel, Intendent Naturhistoriska Riksmuseum (plant-paleontological department), Stockholm (delegate, Royal Swedish Academy of Science, Stockholm).

Nijland, Albert Antonie, professor of astronomy, University of Utrecht (delegate, University of Utrecht).

Perkin, William Henry, F.R.S., professor of chemistry, Victoria University of Manchester.

Pope, William Jackson, F.R.S., professor of chemistry, University of Cambridge.

Prain, Lt.-Col. David, F.R.S., director, Royal Botanic Gardens, Kew (delegate, Linnean Society, London).

Prince, Edward E., F.R.S., Dominion Commissioner of Fisheries, Ottawa, Canada.

Reddingius, Rutger Adolf, professor of pathological anatomy, rector, University of Gröningen (delegate, University of Gröningen).

Royce, Josiah, professor of history of philosophy, Harvard University.

Saundby, Robert, professor of medicine, University of Birmingham (president-elect British Medical Association).

Schäfer, Edward Albert, F.R.S., professor of physiology, Edinburgh University.

Schuster, Arthur, F.R.S., formerly professor of physics, University of Manchester.

Teall, Jethro Justinian Harris, director H.M. Geological Survey, London.

Thomson, Sir Joseph John, F.R.S., professor of physics, Cambridge.

Veit, Johann, professor of gynecology, University of Halle (delegate, University of Halle-Wittenberg).

Voigt, Woldemar, professor of physics, University of Göttingen.

Watts, William Whitehead, F.R.S., professor of geology, Imperial College of Science and Technology, South Kensington (president and delegate, Geological Society of London).

Woodward, Arthur Smith, F.R.S., keeper geological department, British Museum.

SCIENTIFIC NOTES AND NEWS

We regret to record the death of Dr. Thomas Dwight, Parkman professor of anatomy in the Harvard Medical School.

Dr. David Starr Jordan, president of Stanford University, who is at present in Japan, has been decorated by the Japanese emperor.

Dr. Eduard Suess, emeritus professor of geology in the University of Vienna, who has celebrated his eightieth birthday, has retired from the presidency of the Vienna Academy of Sciences.

Dr. Gottlieb Haberlandt, professor of botany in the University of Berlin, has been elected a member of the Berlin Academy of Sciences.

Mr. Wm. Paul Gerhard, of New York, has been awarded the honorary degree of doctor of engineering by the Technical Institute of Darmstadt, in recognition of his services to public health and sanitation.

Dr. Shigéo Yamanouchi, professor of botany in Tokyo Teachers' College (now in the University of Chicago), received in July from the Japanese government the honorary degree of "Rigakuhakushi" (doctor of science).

Professor Gaetano Lanza, head of the department of mechanical engineering at the Massachusetts Institute of Technology for the past twenty-seven years, has retired and is now with the Baldwin Locomotive Works.

Dr. William H. Brown has resigned his position as research assistant in plant physiology at the Michigan Agricultural College to become plant physiologist of the Bureau of Science at Manila, P. I. He sailed from San Francisco for the latter point on September 6. Dr. R. P. Hibbard, of the Mississippi Agricultural Experiment Station, has been chosen as his successor.

Dean Melvin A. Brannon, formerly of the College of Medicine at the University of North Dakota but now of the College of Liberal Arts at the same institution, will spend the year at the University of Chicago engaged in advanced research work in plant morphology with special reference to bryophytes and

pteridophytes. His work will have a particular bearing on certain problems in the study of plant life that are being worked out in North Dakota.

PROFESSOR HENRY E. CRAMPTON, of Columbia University and the American Museum of Natural History, is at present on leave of absence and is taking part in an expedition which has penetrated the interior of South America in search of zoological material.

DR. J. GEORGE ADAMI, professor of pathology in McGill University, has gone to Europe to attend the Tuberculosis Conference in Rome.

DR. P. G. SPINELLI, professor of gynecology in the University of Naples, is making a study of hospitals in the United States.

MESSRS. V. KOTCHETKOFF, of the department of agriculture, Moscow, and D. Roodzinski, director of the Selection Station of the Moscow Agricultural Institute, spent several days recently in a study of the work of the Bureau of Plant Industry and especially the work of the bureau farm at Arlington, Va., as an introduction to a six months' investigation of agricultural methods and conditions in the United States.

THE Harvey Society has secured the following distinguished lecturers for the coming season: Professor W. B. Cannon, of Harvard Medical School; Professor R. H. Chittenden, of Yale University; Dr. Simon Flexner, of the Rockefeller Institute; Professor H. S. Jennings, of Johns Hopkins University; Professor Albrecht Kossel, of Heidelberg University; Dr. H. F. Osborn, of the American Museum of Natural History; Dr. J. J. Putnam, of Harvard Medical School; Professor T. W. Richards, of Harvard University; Professor W. T. Sedgwick, of the Massachusetts Institute of Technology; Dr. W. S. Thayer, of the Johns Hopkins Medical School, and Professor Verworn. The following lectures will be delivered during the month of October: "Local Specific Therapy of Infections," by Dr. Simon Flexner, on the 7th; "The Chemical Structure of the Cell," by Professor Albrecht Kossel, on the 14th; "Anesthesia," by Professor Verworn, on the 28th.

MR. J. R. MORTIMER, of Driffield, England, known for his work in prehistoric archeology, died on August 20, in his eighty-seventh year.

DR. G. F. BLANDFORD, formerly lecturer on psychological medicine at St. George's Hospital, London, and known for his work on insanity, has died at the age of eighty-two years.

DR. EMANUEL VON HIBLER, professor of pathological anatomy in the University of Innsbruck, has died from sepsis contracted in the *post-mortem* room.

DR. GEORGES DIEULAFOY, formerly professor of clinical medicine at the University of Paris, has died at the age of sixty-two years.

THE death is also announced of Professor Swarts, of the University of Genth, known for his contributions to chemistry.

DR. FRANZ CZERMAK has bequeathed a million crowns to the Vienna Academy of Sciences without restriction as to its use.

A SETTLEMENT has been arrived at in regard to the question of the South Kensington site by the terms of which the Natural History Museum retains all the land allotted to it in 1899, and the boundary then agreed upon is not to be disturbed. The Science Museum will be proceeded with on the land to the north of the boundary of the Natural History Museum.

Nature reports that at the National Congress of Applied Chemistry, which is to be held at Turin from September 23 to 28, a general discussion will take place on the fiscal and customs practise in regard to the industrial use of alcohol, and Professor Miolati will give an experimental demonstration of the use of atmospheric nitrogen for industrial purposes.

IT is stated in the *British Medical Journal* that the third Congress of the International Surgical Society will be held at Brussels at the end of the month. The members will be received on Monday evening, September 25,

by Dr. Lorthioir, president of the Belgian Surgical Society. The congress and the exhibition of fractures and surgical appliances will be opened at 9.30 on Tuesday morning, and immediately afterwards a discussion on pancreatitis will be opened by M. Michel. The afternoon session will be devoted to the discussion of the treatment of that disease, opened by MM. Körte and Giordano. In the evening the president of the International Society (Professor Lucas-Championnière) will hold a reception. Wednesday will be devoted to the surgery of the thorax, the introductory addresses being given by MM. Garrè, Gaudier, Girard, Lenormand and Ferguson. Thursday morning will be given up to demonstrations of fractures, and the afternoon to the discussion of pulmonary abscess and gangrene and bronchiectasis, introduced by MM. Van Stockum and Sauerbruch. Subjects for discussion on Friday are the surgical treatment of pulmonary tuberculosis and acute and chronic colitis. There will be a banquet on Thursday evening, and a gala performance at the Theater Royal on Friday evening.

THE Harpswell Laboratory was open during the season just closed from June 15 to September 11. During this time the following investigators carried on work there:

George A. Bates, professor of histology, Tufts Medical School, Boston.

Violet Dandridge, artist, U. S. National Museum, Washington.

Reuben J. Erickson, student, Knox College, Galesburg, Ill.

C. McLean Fraser, assistant, University of Iowa, Iowa City.

Abram T. Kerr, professor of anatomy, Cornell University, Ithaca.

Agnes R. Kerr, Ithaca.

Duncan S. Johnson, professor of botany, Johns Hopkins University, Baltimore.

J. S. Kingsley, professor of zoology, Tufts College, Tufts College, Mass.

Margaret Reed Lewis, Baltimore.

Warren H. Lewis, assistant professor of anatomy, Johns Hopkins University, Baltimore.

Herbert V. Neal, professor of zoology, Knox College, Galesburg.

Mary J. Rathbun, curator of invertebrates, U. S. National Museum, Washington.

Marian L. Shorey, professor of zoology, Milwaukee-Downer College, Milwaukee.

Leonard W. Williams, instructor in comparative anatomy, Harvard Medical School, Boston.

THE *Scottish Geographical Magazine* quotes the excursions to be made from October 23 to November 1, after the holding of the International Geographical Congress in Rome. Of these the first or northern excursion is to the lower valley of the Po and the Fore Alps. The starting-point is Ferrara, where the delta of the Po will be examined and a steamer journey on the river undertaken from Pontelagurasco to Mantua. Verona will then be visited, and the lakes of Garda and Iseo. The valley of the Serio will be traversed, special attention being paid to the development of industries here, and the use of water power. From Bergamo the lakes of Como and Maggiore will be crossed, thence the party will descend to Milan, where various scientific and industrial undertakings will be visited. On the way to Turin the town of Novara will be examined. The total expenses of this excursion will not exceed 380 Italian lire, and the objects of study will be physical and economic geography. Participants will be presented with a monograph of the delta of the river Po, with maps, especially prepared by Professor Mario Barrata, of the University of Pavia. The second excursion is to Naples, Palermo and the coasts of eastern Sicily and Calabria, and will be devoted to physical geography and vulcanology. The party is to meet at Naples, where a day will be devoted to the sights of the neighborhood, a choice having to be made between the three following: Vesuvius and Pompeii, the Phlegrean Fields or Capri. On the twenty-fourth of October the party will start by steamer for Palermo, traveling next day to Catania, where Mount Etna can be ascended or a tour made round its circumference. Thence the ruins of Messina and Reggio and the rebuilding of these towns will be examined. From Reggio excursions will be taken to the neighboring coastline to inspect the effects of the earthquake, and a return will

be made to Messina, where the steamer will be taken to Naples again. This excursion will not cost more than 358 lire. The third excursion is a variant of the preceding, but gives more time to Naples and its vicinity. It allows three days for Naples, and joins up with the other excursion at Catania. The cost will be about 366 lire. All excursionists are invited to visit the exhibition at Turin on November 1, and on the evening of that day the excursion will be regarded as closed.

UNIVERSITY AND EDUCATIONAL NEWS

THE Japanese Minister of Education has announced that two new imperial universities will be opened. One will be at Sendai, on the eastern coast, and the other at Fukuoka, on the island of Kiushu.

DR. JACK P. MONTGOMERY, of the Mississippi Agriculture and Mining College, has been appointed adjunct professor of chemistry at the State University of Alabama.

HOMER C. WASHBURN, B.S., Ph.C., has been appointed professor of pharmacy in the University of Colorado. He is a graduate of the scientific and pharmaceutical departments of the University of Michigan. For seven years he has been a member of the faculty of the University of Oklahoma and for the last six years dean of the School of Pharmacy.

MR. W. A. WHITAKER, JR., of the department of chemistry, College of the City of New York, has accepted the associate professorship of metallurgy in the University of Kansas.

S. D. MAGERS, assistant professor of physiology in the Michigan State Normal College, Ypsilanti, succeeds Dr. E. R. Downing as professor of biology at the State Normal at Marquette, Mich.

THOMAS L. PATTERSON, M.A., with the Gypsy Moth Parasite Laboratory during the past summer, has been elected professor of biological sciences at Highland Park College, Des Moines, Iowa.

RECENT appointments at the State University of North Dakota are the naming of H. E. French, A.B. (Washington State, 1902), M.D. (Northwestern, 1907), and recently of the medical school of the University of South Dakota, as dean of the School of Medicine; Carl F. Raver, A.B. (Michigan), recently city bacteriologist for Oklahoma City, Oklahoma, as chemist in the State Public Health Laboratory; Roy E. Christie, A.B. (North Dakota, 1911), as assistant bacteriologist at the same place; Leon V. Parker, as bacteriologist in charge at the branch Public Health Laboratory at Minot, and Alfred Larson to fill a similar position in the branch laboratory at Bismarck.

DISCUSSION AND CORRESPONDENCE

THE GRAND CANYON OF THE COLORADO

ON page 89 of SCIENCE, No. 864 (July 21, 1911), I observe a special article by H. H. Robinson entitled "The Single Cycle Development of the Grand Canyon of the Colorado."

During the summer and autumn of 1908 I spent several months in the Grand Canyon in the region about Shinumo Creek, making a study of the geology of the Shinumo quadrangle. The results of this study were presented at Yale University in the form of a Doctor's thesis, a part of which, dealing with the rocks of the Vishnu and Grand Canyon series, has been published in the *American Journal of Science* (May and June, 1910) under the title "Contributions to the Geology of the Grand Canyon." I have since returned twice to the region to extend the same study in the interest of the United States Geological Survey; the entire report on the geology of the Shinumo quadrangle is to be published at a future date as a Bulletin of the Geological Survey.

My observations in that region (recorded in the thesis, but not yet published) are entirely in accord with the conclusions of Davis and Robinson in regard to the dependence of the benches in the canyon upon the character of the strata.

The Shinumo quadrangle is a critical area for the study of the two greatest benches within the canyon, the Esplanade and the Tonto Platform, since it is there that the profile of the canyon wall changes from that which is characteristic of the Kaibab division to that which is characteristic of the Kanab. Eastward from Havasupai Point, a great promontory of the southern wall in the center of the quadrangle near Bass Camp, the scenery is that which is characteristic of the Kaibab division. This is the scenery that is familiar to most of the visitors at the Grand Canyon, from the views in the vicinity of El Tovar hotel. The walls are greatly dissected, particularly on the northern side of the canyon. Great amphitheaters run far back into the wall, filled with fantastic buttes and temples, and trenched by innumerable side gorges. The profile of the wall is especially distinctive; the edges of the Paleozoic strata descend rapidly through a series of cliffs, steep slopes, and narrow ledges to the Tonto Platform, 3,000 feet below the rim of the canyon; within the Tonto Platform is the Granite Gorge, at the bottom of which the river flows upon Archean rocks.

Turning westward from Havasupai Point, there is a striking change. Directly below, about 1,000 feet beneath the rim, a great flat-topped spur of red Supai sandstone runs far out into the canyon. Farther westward, more and more of these spurs appear, each capped with a similar platform which always lies upon the same layer of red sandstone. Gradually the platform widens and becomes a broad expanse of red rock, which is covered with patches of scanty soil and dotted with scrubby trees of juniper and pinyon. The buttes and temples disappear; the walls are much less dissected by side gorges and extend in solemn palisades. The cross-section of the canyon wall is more simple, consisting of a wide outer valley whose floor is the great red platform, and a narrow inner canyon, at the bottom of which is the river. This platform is named the Esplanade. The wall of the inner canyon is stupendous, the edges of the Tonto, Redwall, and Supai strata appearing almost as a single cliff, 3,000 feet in height. This type of scenery is characteristic of the entire canyon west of the Kaibab division.

Opposite Havasupai Point, in the central part of the quadrangle both platforms are present, separated vertically by 2,000 feet. It is therefore manifestly impossible that the two platforms represent one base-level of erosion.

The greater dissection of the walls in the Kaibab division is, of course, due to the greater altitude of the plateaus on either side of the canyon and the consequently greater rainfall that prevails.

The change in the profile of the wall to the westward can be clearly shown to depend upon certain variations in the thickness and character of the Paleozoic strata: Each ledge of the canyon wall is made by the wasting back of beds of weak strata from the summit of a resistant, cliff-making stratum below. The width of a ledge tends to increase with the thickness of the weak strata; it is also controlled by the relative thickness and strength of the overlying strata which defend the retreat of the wall above.

In the Kaibab division, the Bright Angel shale of the middle part of the Tonto group is uniformly weak and has wasted back rapidly from the summit of the basal Tapeats sandstone of the Tonto group, leaving the wide ledge known as the Tonto Platform. As the Bright Angel shale is traced westward into the Shinumo quadrangle, layers of resistant snuff-colored limestone begin to appear in the middle of the formation. These layers, known locally as the Snuffy limestone, gradually increase in thickness, making two delicate parallel cliffs which are a conspicuous feature in the interior of the canyon. The Snuffy limestone increases the resistance of the Bright Angel shales to erosion, so that they retreat more slowly and make a steeper slope; westward from Havasupai Point the Tonto Platform fades gradually and is no longer a prominent topographic feature in the canyon. At the same time, the Muav limestone of the upper part of the Tonto

group and the massive Redwall become gradually thicker to the northward and westward, and the inner canyon narrows as these strata become more and more effective in defending the retreat of the wall.

In the Kanab division, the Supai formation of the Aubrey group consists of weak red shales in the upper portion and resistant sandstones below. The shales waste back from the summit of the sandstones, leaving the Esplanade platform. In the western part of the quadrangle, where the Esplanade is fully developed, the thickness of the Supai shales is 550 feet; while that of the overlying massive white Coconino sandstone, which defends the retreat of the outer wall, is only 250 feet. Eastward from Havasupai Point, in the Kaibab division, the thickness of the Supai shale has decreased to 300 feet (becoming still thinner in the Bright Angel quadrangle to the eastward); while that of the Coconino sandstone has increased to 400 feet; the Esplanade fades to a narrow ledge in this part of the canyon.

L. F. Noble

Valyermo, California,
July 27, 1911

DRAUGHTS AND COLDS

To the Editor of Science: In reading the interesting and instructive communication by Mr. M. Mott-Smith in the August 4 number of Science, I was impressed by the closing paragraph, which follows:

> Though the above explanations are only a rehash of well-known principles, I hope they may be of some use. In return I wish some one would explain to me just what is the danger of the open window. Why is a little sneaking draught in the house a source of colds and grippe, while a high wind out of doors a pleasure and a benefit? This is a problem that has long puzzled me, but perhaps it is a foolish question.

This problem has doubtless puzzled a great many besides Mr. Mott-Smith, and is perhaps "a foolish question"; but why it should be a *foolish question* seems also a puzzle to a layman. The problem appears to involve the question, what is the pathology of a "bad cold"? The writer has propounded that question to several intelligent physicians, and its "foolishness" is attested by failure to elicit any attempt at a lucid reply.

The writer has been compelled to construct for himself what engineers would call a "working hypothesis" to cover this problem. and has even ventured to apply a quasi scientific name to fit the case, which is offered as a reply to Mr. Mott-Smith for what it may be worth, or otherwise, with all due diffidence and a proper sense of his temerity in trenching upon hallowed ground.

The answer thus boldly formulated as to the proximate cause of a "bad cold" is, *a disturbance of the thermo-neural equilibrium* of the surface of the body.

It is a matter of common experience that if a portion of the body, the head and neck, for instance, is exposed to a strong breeze while the remainder of the body is of normal or supernormal temperature, bad cold, grippe, etc., are pretty sure to result, while the "high wind out of doors," which envelops the whole body, has no such effect. One sitting in a country office on a very cold day, his feet thrust under a desk and his back to a glowing grate, shall after a while fall to sneezing, and if he is wise he will get up and stir around in order to restore this disturbed equilibrium in the temperature of the cutaneous nerves.

In this connection it may be said that the writer has found what is to him a completely satisfactory solution of the weighty question, how to deal with the long and oppressive summer heat in the southern states, to wit, the electric fan.

Nearly all persons are afraid to allow a fan to blow upon them while asleep; and indeed if the body is partially exposed to the action of the fan it is a dangerous practise. On the other hand it is the writer's constant practise to have a 16-inch fan blowing upon him all night in hot weather. When the temperature is very high the fan is run at top speed, and is graduated down for lower temperatures.

The point to be made is, that the fan is so located that it is in line with the sleeper's body, taking him from his feet to his head, and thus enveloping his entire body in the

volume of moving air. By this method of application of the fan there is no disturbance of the "thermo-neural" equilibrium of the body, and the writer has thus enjoyed the luxury of a cool bed without stint, in the hottest weather, without any evil effects.

It is the hope that others may profit by the above suggestion, that shall serve as an apology for this communication.

T. G. Dabney

Clarksdale, Miss.,
August 13, 1911

BLANDING'S TURTLE

To the Editor of Science: Mr. Howe's note in Science of September 1, reporting the capture of Blanding's turtle in Massachusetts, reminds me that I should make a note of the introduction of this turtle in Orange County, New York.

In 1909 I placed three pairs of Blanding's turtle (*Emys blandingi*) and three pairs of the map turtle (*Malacoclemmys geographica*) in Little Long Pond, near Southfields, Orange County. Some naturalist may discover them by and by, and it is desirable that a record be made of their introduction. Both species were collected in Erie County, Ohio.

C. H. Townsend

New York Aquarium

QUOTATIONS

MEDICAL PRACTISE IN GREAT BRITAIN

As every one knows, the lines of work pursued by medical men vary greatly in different cases. Of all medical students a large proportion probably hope to develop into consultants or specialists, but sooner or later they learn that it is only to the few that a career of this kind is practically open. Even after a brilliant studentship success involves years of weary waiting, during which not even a bare living is made from practise; and, in fact, only those who have private means can afford, as a rule, to wait. Moreover, in every case the result is extremely uncertain, and one late outcome of legislation now in progress may be restriction of the field open to consultants and specialists of independent mind.

Despite, therefore, the apparent wealth of choice, the average newly qualified man has to elect between private general or family practise and an official career. Most men necessarily choose the former, if only for the reason that the number of posts in the public services is very limited. It is the more unfortunate, therefore, that the prospects of private practise are inferior to what they used to be. Complaints of lessened incomes and increased expenses began, indeed to come in a few years ago in such numbers that the subject was specially investigated by this *Journal,* and the results recorded in two articles on "The Financial Prospects of Medicine," which appeared in the *British Medical Journal* for June 12 and July 17, 1909. The net outcome of those articles was to prove that not only was the number of possible patients less, but each one of those that remained needed less medical attendance than formerly, especially for the zymotic diseases, which used to furnish so much work. In this connection must be mentioned the decline in the birthrate, which not only affects the medical men of this generation, but must seriously influence the prospects of those who may succeed them. The counter-prescribing by chemists, the enormous sale of quack remedies, the growth of badly-paid club practise and of hospital abuse, have all taken away from medical men former paying patients. At the same time the State has from time to time thrown sundry unpaid duties on the shoulders of medical men.

The state has no conscience, but individual members of the public often seem, in their dealings with medical men, to have very little. The newly-qualified practitioner often thinks he is making a practise quickly, judging by the number of patients that come to his surgery, but too often he is disillusioned when he sends out his bills. If he press for payment before he is well established, the growth in his practise soon ceases, and, what is still more irritating, the very patients who had seemed to regard him as an angel of mercy not infrequently spread charges of incompetence or

neglect which, however fully disproved, invariably damages his practise.

The foregoing is a faithful account of the present drawbacks to private practise, and it must be repeated that the insurance legislation in view will not improve matters. Medical men who have gone in for contract practise at all have been able to afford to do so thanks to their possession also of ordinary practise among the same class of persons. But under the National Insurance Bill the whole of the working class will be swept into the contract practise net, and a smaller income will almost certainly result from the same amount of work despite the absence of bad debts. There may also be an extension upwards of the contract system, and a great deal even of the best class of private practise may thus be abolished. Another disadvantage which can not be ignored is that it will become impossible to build up a practise which can be sold in part or altogether. Indeed the mere introduction of the bill has already lessened the value of many practises as facultative assets.—*British Medical Journal.*

SCIENTIFIC BOOKS

Publications of the United States Naval Observatory. Second Series. Volume VI., with ten plates. Volume VII. Washington, Government Printing Office. 1911.

In accordance with the new policy of the Naval Observatory by which volumes are issued from time to time as material suitable in nature and quantity for simultaneous publication becomes available, we find volume VI. of the present two volumes made up as follows: (1) the data and results of all the observations made with the two equatorial telescopes, the 26-inch and the 12-inch, since the removal to the new site, or for the years 1894–1907; (2) Appendix I., a series of thirty-six astronomical papers by various members of the staff, embracing a determination of the mass of Titan, of the Solar Parallax from observations of Eros, and determinations of the orbits of a number of satellites, minor planets and comets; (3) Appendix II., a presentation of the observations of the transit of Mercury in 1894 made by more than twenty-three professional and amateur astronomers at as many stations in the United States from the Atlantic to the Pacific coast; (4) Appendix III., a complete and minutely described list of the publications of the observatory, from the beginning in 1845 till 1908.

This volume is of special interest to a wider public inasmuch as it contains, we believe, the first series of plates that have been generally distributed in illustration of the buildings and equipment of the new observatory. The frontispiece exhibits the dome and the attached, low, office building of the great equatorial telescope, making one harmonious structure, with white marble walls, standing apart on the spacious grounds. Probably this is the most gracefully formed astronomical dome in the country, if not in the world. Similar praise is to be given when we regard the plate which gives a view of the front of the main building. Here, again are fitness and beauty of proportion, a simplicty of outline and detail, which are an honor to the architect, the late Richard Morris Hunt. Besides these there are six plates which exhibit the construction and equipment of the 26-inch telescope and one which gives a general view of the 12-inch telescope.

This volume contains the work of a number of observers who have succeeded one another at the instruments in kaleidoscopic change. Indeed, one who has followed the annual pamphlet reports of the superintendent for several years past, is likely to have his head full of visions of a chain of observers marching and counter-marching around a circle of instruments, and to get the conviction that our National Observatory properly belongs in Alice's Wonderland. But here is a great mass of original astronomical data which appear to have been carefully derived, and the full value of which can only come out upon comparison with similar results from the different observatories of the world. If certain astronomers, of a type not unrepresented in this volume, would confine themselves to careful observation and leave the theorizing in newspaper and magazine articles

to others of less exuberant imagination, current astronomy might stand better with the intelligent public.

Of Appendix I. special mention may be made of the following determinations: of the mass of Titan by Professor Eichelberger from observations made by the late Professor Asaph Hall at the old observatory; of the orbits of Deimos and Phobos by Mr. J. C. Hammond, from the observations made by Mr. H. L. Rice, and of the solar parallax by Mr. C. W. Frederick, from observations of Eros made by Professor See. Then follows a long series of determinations of orbits for members of that swarm of tiny planets known as asteroids, which the astronomical student is inclined to believe were designed by an unkind Providence to furnish exercises in computation, but which may yet again develop some new and important interest. Here it is a pleasure to find that Mr. Matt Frederickson employs his ingenuity to derive a simple, explicit equation for a certain unknown in place of the implicit equation solved by previous computers by means of a series of approximations.

Volume VII. might be classed under Archeology, inasmuch as it is presentation of results of observations made on three old meridian instruments in the period 1846–1852. The work of reduction and preparation for publication has only recently been done, under the leadership of Professors Eichelberger and Littell, and seems to owe its completeness very largely to the faithful and intelligent service by Miss Etta M. Eaton. This is a work, both as to observation and computation, which hardly any but a government observatory would be willing to undertake. The exhiliration of spirits arising from such deferred labor is like that due to a campaign of elimination in the garret when a family moving is at hand. Yet unsuspected values may develop amongst its results; and the recent discovery of a large drift in space on the part of a star whose earliest known position is recorded in the old Gilliss Catalogue of 1850, also worked up at our national observatory, is a cheering incident to the patient laborers in this field.

A large part of the transit observations entering into Volume VII., from the earlier part of the period, were made by the eye and ear method, which is still in vogue for occasional observations. In connection with the summary of measures of accidental errors affecting the results in this catalogue, it is interesting to note here, what seems almost incredible to the beginner, that the employment of the electric chronograph reduced the accidental error by only slightly over six per cent. As is well known, the liability to accidental error in the case of the experienced observer is sensibly the same in both methods.

These two volumes are dignified and handsome products from the Government Printing Office. One important economic problem of the day is the condensed presentation of scientific and other data without detracting from a proper appearance and a form intelligible in reference. The present volumes are too expansive in some portions but show in other parts a commendable tendency to compactness.

ALBERT S. FLINT

Polar Exploration. By Dr. W. S. BRUCE. New York, Henry Holt & Co. 1911. Pp. 256.

The geographer, the scientist and the intelligent, enquiring reader will alike find this volume of the Home University Library most disappointing. The most that can be said in its favor is the pleasant, though often inconsequential manner in which the author puts forward descriptive phases of polar physics, in which he is personally interested. It is evidently written for the English market only. Entitled "Polar Exploration," it makes no mention of the polar work of Kane, Hayes, Rodgers, De Long, Greely, Lockwood or any other American, save to refer to "the boyish pole hunt," and a sea-sounding by Peary. There are desultory chapters on Plant and Animal Life, Meteorology and Magnetism, but no reference to the incomparable scientific observations of the International Polar Station by thirteen nations, published in forty quarto volumes.

A. W. GREELY

SPECIAL ARTICLES

RANDOM SEGREGATION VERSUS COUPLING IN MENDELIAN INHERITANCE

Mendel's law of inheritance rests on the assumption of random segregation of the factors for unit characters. The typical proportions for two or more characters, such as 9:3:3:1, etc., that characterize Mendelian inheritance, depend on an assumption of this kind. In recent years a number of cases have come to light in which when two or more characters are involved the proportions do not accord with Mendel's assumption of random segregation. The most notable cases of this sort are found in sex-limited inheritance in *Abraxas* and *Drosophila,* and in several breeds of poultry, in which a coupling between the factors for femaleness and one other factor must be assumed to take place, and in the case of peas where color and shape of pollen are involved. In addition to these cases Bateson and his collaborators (Punnett, DeVilmorin and Gregory) have recently published[1] a number of new ones.

In order to account for the results Bateson assumes not only coupling, but also repulsions in the germ cells. The facts appear to be exactly comparable to those that I have discovered in *Drosophila,* and since these results have led me to a very simple interpretation, I venture to contrast Bateson's hypothesis with the one that I have to offer.

The facts on which Bateson bases his interpretation may be briefly stated in his own words, namely: "that if *A, a* and *B, b* are two allelomorphic pairs subject to coupling and repulsion, the factors *A* and *B* will repel each other in the gametogenesis of the double heterozygote resulting from the union $Ab \times aB$, but will be coupled in the gametogenesis of the double heterozygote resulting from the union $AB \times ab$," and further, "We have as yet no probable surmise to offer as to the essential nature of this distinction, and all that can yet be said is that in these special cases the distribution of the characters in the heterozygote is affected by the distribution in the original pure parents." Bateson further points out that since "sex in the fowls acts as a repeller of at least three other factors, . . . some of them may be found able to take precedence of the others in such a way as to annul the present repulsion with subsequent coupling as a consequence."

In place of attractions, repulsions and orders of precedence, and the elaborate systems of coupling, I venture to suggest a comparatively simple explanation based on results of inheritance of eye color, body color, wing mutations and the sex factor for femaleness in *Drosophila.* If the materials that represent these factors are contained in the chromosomes, and if those factors that "couple" be near together in a linear series, then when the parental pairs (in the heterozygote) conjugate like regions will stand opposed. There is good evidence to support the view that during the strepsinema stage homologous chromosomes twist around each other, but when the chromosomes separate (split) the split is in a single plane, as maintained by Janssens. In consequence, the original materials will, for short distances, be more likely to fall on the same side of the split, while remoter regions will be as likely to fall on the same side as the last, as on the opposite side. In consequence, we find coupling in certain characters, and little or no evidence at all of coupling in other characters; the difference depending on the linear distance apart of the chromosomal materials that represent the factors. Such an explanation will account for all of the many phenomena that I have observed and will explain equally, I think, the other cases so far described. The results are a simple mechanical result of the location of the materials in the chromosomes, and of the method of union of homologous chromosomes, and the proportions that result are not so much the expression of a numerical system as of the relative location of the factors in the chromosomes. *Instead of random segregation in Mendel's sense we find "associations of factors" that are located near together in the chromosomes. Cytology furnishes the mechanism that the experimental evidence demands.*

T. H. Morgan

September 10, 1911.

[1] *Proc. Royal Soc.,* Vol. 84, 1911

SCIENCE

FRIDAY, SEPTEMBER 29, 1911

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THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE ETHNOLOGICAL ANALYSIS OF CULTURE[1]

DURING the last few years great additions have been made to our store of the facts of anthropology—we have learned much about different peoples scattered over the earth and we understand better how they act and think. At the same time we have, I hope, made a very decided advance in our knowledge of the methods by means of which these facts are to be collected, so that they may rank in clearness and trustworthiness with the facts of other sciences. When, however, we turn to the theoretical side of our subject, it is difficult to see any corresponding advance. The main problems of the history of human society are little, if at all, nearer their solution, and there are even matters which a few years ago were regarded as settled which are to-day as uncertain as ever. The reason for this is not far to seek; it is that we have no general agreement about the fundamental principles upon which the theoretical work of our science is to be conducted.

In surveying the different schools of thought which guide theoretical work on human culture, a very striking fact at once presents itself. In other and more advanced sciences the guiding principles of the workers of different nations are the same. The zoologists or botanists of France, Germany, America, our own and other countries, are on common ground. They have in general the same principles and the same methods, and the work of all

[1] Address of the president to the Anthropological Section. Portsmouth, 1911.

falls into a common scheme. Unfortunately this is not so in anthropology. At the present time there is so great a degree of divergence between the methods of work of the leading schools of different countries that any common scheme is impossible, and the members of one school wholly distrust the work of others whose conclusions they believe to be founded on a radically unsound basis.

I propose to consider in this address one of the most striking of these divergences, but, before doing so, I will put as briefly as possible what seem to me to be the chief characters of the leading schools of different countries. To begin with that dominant among ourselves. The theoretical anthropology of this country is inspired primarily by the idea of evolution founded on a psychology common to mankind as a whole, and further, a psychology differing in no way from that of civilized man. The efforts of British anthropologists are devoted to tracing out the evolution of custom and institution. Where similarities are found in different parts of the world it is assumed, almost as an axiom, that they are due to independent origin and development, and this in its turn is ascribed to the fundamental similarity of the workings of the human mind all over the world, so that, given similar conditions, similar customs and institutions will come into existence and develop on the same lines.

Britain

In France we find that, as among ourselves, the chief interest is in evolution, and the difference is in the principles upon which this evolution is to be studied. It is to the psychological basis of the work of British anthropologists that objection is chiefly made. It is held that the psychology of the individual can not be used as a guide to the collective actions of men in early stages of social evolution, still less the psychology of the individual whose social ideas have been molded by the long ages of evolution which have made our own society what it is. It is urged that the study of sociology requires the application of principles and methods of investigation peculiar to itself.[2]

About America it is less easy to speak, because it is unusual in that country to deal to any great extent with general theoretical problems. The anthropologists of America are so fully engaged in the attempt to record what is left of the ancient cultures of their own country that they devote little attention to those general questions to which we, more unfortunately situated with no ancient culture at our doors, devote so much attention. There seems, however, to be a distinct movement in progress in America which puts the evolutionary point of view on one side and is inclined to study social problems from the purely psychological point of view, the psychological standpoint, however, approaching that of the British school more nearly than that of the French.[3]

It is when we come to Germany that we find the most fundamental difference in standpoint and method. It is true that in Adolf Bastian Germany produced one who was thoroughly imbued with the evolutionary standpoint, and the *Elementargedanke* of that worker forms a most convenient expression for the psychological means whereby evolution is supposed to have

[2] I refer here especially to the work of the "sociological" school of Durkheim and his followers. For an account of their principles and methods see *L'Année sociologique*, which began to appear in 1898; Durkheim, "Les Règles de la Méthode Sociologique," Paris; and Lévy-Bruhl, "Les fonctions mentales dans les sociétés inférieures," Paris, 1910.

[3] See especially A. L. Kroeber, "Classificatory Systems of Relationship," *Journ. Roy. Anthr. Inst.*, 1909, XXXIX., 77; and Goldenweiser, "Totemism: An Analytical Study," *Journ. Amer. Folk-Lore*, 1910, XXIII.

proceeded. In recent years, however, there has been a very decided movement opposed to Bastian and the whole evolutionary school. In some cases this has formed part of that general revolt not merely against Darwinism which is so prominent in Germany, but it seems even against the whole idea of evolution. In other cases the objection is less fundamental, and has been not so much to the idea of evolution itself as to the lines upon which it has been customary to endeavor to study this evolution.

This movement, which by those who follow it is called the geographical movement, but which, I think, may be more fitly styled "ethnological," was originated by Ratzel, who was first led definitely in this direction by a study of the armor made of rods or plates or laths which is found in North America, northern Asia, including Japan, and in a less developed form in some of the islands of the Pacific Ocean.[4] Ratzel believed that the resemblances he found could only be explained by direct transmission from one people to another and was led by further study to become an untiring opponent of the *Elementargedanke* of Bastian and of the idea of independent evolution based on a community of thought.[5] He has even suggested that the idea of independent origin is the anthropological equivalent of the spontaneous generation of the biologist and that anthropology is now going through a phase of development from which biology has long emerged.

The movement initiated by Ratzel has made great progress, especially through the work of Graebner[6] and of P. W. Schmidt.[7] It has resulted in an important series of works in which the whole field of anthropological research is approached in a manner wholly different from that customary in this country.[8] I must content myself with one example to illustrate the difference of standpoint which separates the two schools. Few subjects have attracted more interest in this and other countries than the study of primitive decoration. In the decorative art of all lands there are found transitions from designs representing the human form or those of animals and plants to patterns of a purely geometrical nature. In this country it has been held, I think I may say universally, that in these transitions we have evidence for an evolutionary process which in all parts of the world has led mankind to what may be called the degradation and conventionalization of human, animal or plant designs so that in course of time they become mere geometrical forms.

To the modern German school, on the other hand, these transitions are examples of the blending of two cultures, one pos-

[4] *Sitzber. d. Akad. d. Wiss. München*, Hist. Cl., 1886, p. 181.

[5] See especially *Anthropogeographie*, 1891, Th. II., 705, and "Die geographische Methode in der Ethnographie," *Geograph. Zeitsch.*, 1897, III., 268.

[6] See especially Graebner, "Methode der Ethnologie," Heidelberg, 1911, and "Die melanesische Bogenkultur und ihre Verwandten," *Anthropos*, 1909, IV., 726. The annual *Ethnologica*, edited by W. Foy, is devoted to the illustration of this school of thought.

[7] See especially "L'origine de l'Idée de Dieu," *Anthropos*, III.–V., 1908–10, and "Grundlinien einer Vergleichung der Religion u. Mythologie der austronesischen Völker," *Denksch. d. Akad. d. Wiss. Wien*, Phil.-hist. Kl., 1910, LIII. Schmidt differs from Graebner in limiting the application of the ethnological method to regions with general affinities of culture. Otherwise he remains an adherent of the doctrine of independent origin. (See "Panbabylonismus und ethnologischer Elementargedanke," *Mitt. d. anthrop. Gesellsch. in Wien*, 1908, XXXVIII., 73.)

[8] It must not be understood from this account that all German anthropologists are adherents of the ethnological school. There are still those who follow the doctrines of Bastian, which have undergone an interesting modification through the adoption of the biological principle of convergence.

sessing the practise of decorating their objects with human, animal or plant designs, while the art of the other is based on the use of geometrical forms. The transitions which have been taken to be evidence of independent processes of evolution based on psychological tendencies common to mankind are by the modern German school ascribed to the mixture of cultures and of peoples. Further, similar patterns, even one so simple as the spiral, when found in widely separated regions of the earth, are held to have been due to the influence of one and the same culture.

I have chosen this example because it illustrates the immense divergence in thought and method between the two schools, but the difference runs through the whole range of the subject. In every case where British anthropologists see evolution, either in the forms of material objects or in social and religious institutions, the modern German school sees only the evidence of mixture of cultures, either with or without an accompanying mixture of the races to which these cultures belonged.

It will, I think, be evident that this difference of attitude of British and German workers is one of fundamental and vital importance. When we find the chief workers of two nations thus approaching their subject from two radically different, and it would seem incompatible, standpoints, it is evident that there must be something very wrong, and it has seemed to me that I can not better use the opportunity given to me by the present occasion than in devoting my address to this subject.

The situation is one which has an especial interest for me in that I have been led quite independently to much the same general position as that of the German school by the results of my own work in Oceania with the Percy Sladen Trust Expedition. With no knowledge of the work of this school I was led by my facts to see how much, in the past, I had myself ignored considerations arising from racial mixture and the blending of cultures, and it will perhaps interest you if I sketch briefly the history of my own conversion.

Much of my time in Oceania was devoted to survey work, in which I collected especially the systems of relationship of every place I visited, together with such other facts concerning social organization as I was able to gather. I began my theoretical study by a comparison of the various forms of these systems of relationship, disregarding at first the linguistic nature of the terms. From the study of these systems I was able to demonstrate the existence, either in the present or the past, of a number of extraordinary and anomalous forms of marriage, such as marriage with the daughter's daughter and with the wife of the father's father,[9] all of which become explicable if there once existed widely throughout Melanesia a state which is known as the dual organization of society with matrilineal descent accompanied by a condition of dominance of the old men which enabled them to monopolize all the young women of the community. Taking this as my starting-point, I was then able to trace out a consistent and definite scheme of the history of marriage in Melanesia from a condition in which persons normally and naturally married certain relatives to one in which wives are purchased with whom no relationship whatever can be traced, and I was able to fit many other features of the social structure of Melanesia into this scheme. So far my work was of a purely evolutionary character, and only served to strengthen me in my previous standpoint.

I then turned my attention to the linguistic side of the systems of relationship,

[9] These terms are used in the classificatory sense.

and a study of the terms themselves showed that these fell into two main classes: one class generally diffused throughout Oceania, while the terms of the other class differed very considerably in different cultural regions. Further, it became clear that the terms of the first class denoted relationships which my comparative study of the forms of the systems had shown to have suffered change, while the terms which varied greatly in different parts of Oceania denoted relationships, such as those of the mother and mother's brother, which there was no reason to believe had suffered any great change in status. From these facts I inferred that at the time of the most primitive stage of Melanesian society of which I had evidence, there had been great linguistic diversity which had been transformed into the relative uniformity now found in Melanesia by the incoming of a people from without, through whose influence the change I had traced had taken place, and from whose language the generally diffused terms of relationship had been borrowed. It was through the combined study of social forms and of language that I was led to see that the change I had traced was not a spontaneous evolution, but one which had taken place under the influence of the blending of peoples. The combined morphological and linguistic study of systems of relationship had led me to recognize that a definite course of social development had taken place in an aboriginal society under the influence of an immigrant people.

I turned next to a Melanesian institution, that of secret societies, concerning which I had been able to gather much new material, and it soon became probable that these societies belonged properly neither to the aboriginal culture nor to that of the immigrants, but had arisen as the result of the interaction of the two; that, in fact, these secret societies had had their source in the need felt by the immigrants for the secret practise of the rites they had brought with them from their former home. A comparison of the ritual of the secret societies with the institutions of other parts of Oceania then made it appear that the main features of the culture of these immigrants had been patrilineal descent, or at any rate definite recognition of the relation between father and child, a cult of the dead, the institution of taboo, and, lastly, certain relations with animals and plants which were probably allied to totemism, if they were not totemism itself in a fully developed form.

Further study made it clear that those I have called the immigrant people, though possessing these features in common, had reached Melanesia at different times and with several decided differences of culture, but that probably there had been two main streams: one which peopled Polynesia and became widely diffused throughout Melanesia, which was characterized by the use of kava; another which came later and penetrated much less widely, which brought with it the practise of chewing betel-mixture. Traces of a third stream, the earliest of all, are probably to be found here and there throughout Melanesia, while still another element is provided by recent Polynesian influence. It became evident that the present condition of Melanesian society has come into being through the blending of an aboriginal population with various peoples from without, and it therefore became necessary to ascertain to which of the cultures possessed by these peoples the present-day customs and institutions of Melanesia belong, always keeping in mind the possibility that some of these institutions may not have belonged to any one of the cultures, but may have arisen as the

result of the interaction of two or more of the blending peoples.

I must be content with this brief sketch of my scheme of the history of Melanesian society, for my object to-day is to point out that if Melanesian society possesses the complexity and the heterogeneous character I have indicated and is the resultant of the mixture of three or four main cultures, it can not be right to take out of the complex any institution or belief and regard it as primitive merely because Melanesian culture on the whole possesses a more or less primitive character. It is probable that some of the immigrants into Melanesia had a relatively advanced culture, possibly even that the institutions and ideas they brought with them had been taken from a culture higher still, and, therefore, when we bring forward any Melanesian institution or belief as an example of primitive thinking or acting, our first duty should be to inquire to which stratum of Melanesian culture it belongs.

To illustrate my meaning I have time for only one example. No concept of Melanesian culture has bulked more largely in recent speculation than that of *mana*, the mysterious virtue to which the magico-religious rites of Melanesia are believed to owe their efficacy. This word now seems on its way to enter the English language as a term for that power or virtue which induces the emotions of awe and wonder, and thus provides a most important element not only in the specific mental states which underlie religion, but also plays much the same part in the early history of magic. In recent speculation the idea of *mana* is coming to be regarded as having been the basis of religious ideas and practises preceding the animism which, following Professor Tylor, we have for long regarded as the earliest form of religion, and *mana* is thus held to be not only the foundation of pre-animistic religion, but also the basis of that primitive element of human culture which can hardly be called either religion or magic, but is the common source from which both have been derived. If I am right in my analysis of Oceanic culture, the Melanesian concept of *mana* is not a suitable basis for these speculations. It is certain that the word *mana* belongs to the culture of the immigrants into Melanesia and not to that of the aborigines. It is, of course, possible that though the word belongs to the immigrant culture, the ideas which it connotes may belong to a more primitive stratum, but this is a pure assumption and one which I believe to be contrary to all probability. At any rate, we can be confident that even if the ideas connoted by the term *mana* belong to or were shared by the primitive stratum of Melanesian society, they must have been largely modified by the influence of the alien, but superior culture from which the word itself has been taken. I believe that the Melanesian evidence can legitimately be used in favor of the view that the power or virtue denoted by *mana* is a fundamental element of religion. The analysis of culture, however, indicates that it is not legitimate to use the Melanesian evidence to support the primitiveness of the concept of *mana*. This evidence certainly does not support the view that the concept of *mana* is more primitive than animism, for the immigrants were already in a very advanced stage of animistic religion, a cult of the dead being certainly one of the most definite of their religious institutions.

Further, I believe that the use of the term *mana* in Melanesia in connection with magic, as a term for that attribute of objects used in magic to which they owe their efficacy, is due to an extension of the original meaning of the term, and that it would only be misleading to use the Melanesian facts as evidence in favor of the

concept of *mana* as underlying primitive magic. Here, again, I do not wish to deny that a concept such as that denoted by *mana* may be a primitive element of magic; all that I wish to point out is that the Melanesian evidence can not properly be used to support this view, for the use of the term in connection with magic in Melanesia is not primitive, but secondary and relatively late.

The point, then, on which I wish to insist is that if cultures are complex, their analysis is a preliminary step which is necessary if speculations concerning the evolution of human society, its beliefs and practises, are to rest on a firm foundation.

I have so far dealt only with Melanesia. It is obvious that the same principle that analysis of culture must precede speculations concerning the evolution of institutions is of wider application, but I have time only to deal, and that very briefly, with one other region.

No part of the world has attracted more attention in recent anthropological speculation than Australia, and at the bottom of these speculations, at any rate in this country, there has usually been the idea, openly expressed or implicitly understood, that in the culture of this region we have a homogeneous example of primitive human society. From the time that I first became acquainted with Australian sociology I have wondered at the complacency with which certain features of Australian social organization have been regarded, and especially the combination of the dual organization and matrimonial classes with what appear to be totemic clans like those of other parts of the world. This coexistence of two different forms of social organization side by side has seemed to me the fundamental problem of Australian society, and I confess that till lately, obsessed as I see now I have been by a crude evolutionary point of view, the condition has seemed an absolute mystery.[10] A comparison, however, of Australia and Melanesia has now led me to see that probably we have in Australia, not merely another example of mixture of cultures, but even another resultant of mixture of the same or closely similar components as those which have peopled Melanesia, viz., a mixture of a people possessing the dual organization and matrilineal descent with one organized in totemic clans, possessing either patrilineal descent, or at any rate clear recognition of the relation between father and child. This is no new view, having been already advanced, though in a different form, by Graebner[11] and P. W. Schmidt.[12] If further research should show Australian society to possess such complexity, it will at once become obvious that here also ethnological analysis must precede any theoretical use of the facts of Australian society in support of evolutionary speculations.

It may be objected that we all recognize the complexity of culture, and indeed in the study of regions such as the Mediterranean, where we possess historical evidence, it is this complexity which forms the chief subject of discussion. Further, where we possess historical evidence, as in the cases of the Hindu and Mohammedan invasions into the Malay Archipelago, all anthropologists are fully alive to the complexities and difficulties introduced thereby

[10] I may note here that Mr. Lang, after having considered this problem from the purely evolutionary standpoint ("Anthropological Essays presented to E. B. Tylor," p. 203), concludes with the words, "We seem lost in a wilderness of difficulties."

[11] *Zeitsch. f. Ethnol.*, 1905, XXXVII., 28, and "Zur australischen Religionsgeschichte," *Globus*, 1909, XCVI., 341.

[12] See especially *Zeitsch. f. Ethnol.*, 1909, XLI., 340.

into the study of culture; but where we have no such historical evidence, the complexity of culture is almost wholly ignored by those who use these cultures in their attempts to demonstrate the origin and course of development of human institutions.

I have now fulfilled the first purpose of this address. I have tried to indicate that evolutionary speculations can have no firm basis unless there has been a preceding analysis of the cultures and civilizations now spread over the earth's surface. Without such analysis it is impossible to say whether an institution or belief possessed by a people who seem simple and primitive may not really be the product of a relatively advanced culture forming but one element of a complexity which at first sight seems simple and homogeneous.

Before proceeding further I should like to guard against a possible misconception. Some of those who are interested in the ethnological analysis of culture regard it not only as the first but as the only task of the anthropology of to-day. I can not too strongly express my disagreement with this view. Because I have insisted on the importance of ethnological analysis, I hope you will not for a moment suppose that I underrate the need for the psychological study of customs and institutions. If the necessity for the ethnological analysis of culture be recognized, this psychological study becomes more complicated and difficult than it has seemed to be in the past, but that makes it none the less essential. Side by side with ethnological analysis there must go the attempt to fathom the modes of thought of different peoples, to understand their ways of regarding and classifying the facts of the universe. It is only by the combination of ethnological and psychological analysis that we shall make any real advance. To-day, however, time will not allow me to say more about this psychological analysis, and I must continue the subject from which I have for a moment turned aside.

Having shown the importance of ethnological analysis, I now propose to consider the process of analysis itself and the principles on which it should and must be based if it in its turn is to have any firm foundation. In the analysis of any culture a difficulty which soon meets the investigator is that he has to determine what is due to mere contact and what is due to intimate intermixture, such intermixture, for instance, as is produced by the permanent blending of one people with another either through warlike invasion or peaceful settlement. The fundamental weakness of most of the attempts hitherto made to analyze existing cultures is that they have had their starting-point in the study of material objects, and the reason for this is obvious. Owing to the fact that material objects can be collected by any one and subjected at leisure to prolonged study by experts, our knowledge of the distribution of material objects and of the technique of their manufacture has very far outrun that of the less material elements. What I wish now to point out is that in distinguishing between the effects of mere contact and the intermixture of peoples, material objects are the least trustworthy of all the constituents of culture. Thus, in Melanesia we have the clearest evidence that material objects and processes can spread by mere contact without any true admixture of peoples and without influence on other features of the culture. While the distribution of material objects is of the utmost importance in suggesting at the outset community of culture, and while it is of equal importance in the final process of determining points of contact and in filling in the details of the mixture of cultures, it is the least satisfactory guide to the actual

blending of peoples which must form the solid foundation of the ethnological analysis of culture. The case for the value of magico-religious institutions is not much stronger. Here, again, in Melanesia there is little doubt that whole cults can pass from one people to another without any real intermixture of peoples. I do not wish to imply that such religious institutions can pass from people to people with the ease of material objects, but to point out that there is evidence that they can and do so pass with very little, if any, admixture of peoples or of the deeper and more fundamental elements of the culture. Much more important is language, and if you will think over the actual conditions when one people either visit or settle among another, this greater importance will be obvious. Let us imagine a party of Melanesians visiting a Polynesian island, staying there for a few weeks and then returning home (and here I am not taking a fictitious occurrence but one which really happens). We can readily understand that the visitors may take with them their betel mixture and thereby introduce the custom of betel-chewing into a new home; we can readily understand that they may introduce an ornament to be worn in the nose and another to be worn on the chest; that tales that they tell will be remembered, and dances they perform will be imitated. A few Melanesian words may pass into the language of the Polynesian island, especially as names for the objects or processes which the strangers have introduced, but it is incredible that the strangers should thus in a short visit produce any extensive change in the vocabulary and still more that they should modify the structure of the language. Such changes can never be the result of mere contact or transient settlement, but must always indicate a far more deeply seated and fundamental process of blending of peoples and cultures.

Few will perhaps hesitate to accept this position, but I expect my next proposition to meet with more scepticism, and yet I believe it to be widely, though not universally, true.[13] This proposition is that the social structure, the framework of society, is still more fundamentally important and still less easily changed except as the result of the intimate blending of peoples, and for that reason furnishes by far the firmest foundation on which to base the process of analysis of culture. I can not hope to establish the truth of this proposition in the course of a brief address, and I propose to draw your attention to one line of evidence only.

At the present moment we have before our eyes an object-lesson in the spread of our own people over the earth's surface, and we are thus able to study how external influence affects different elements of culture. What we find is that mere contact is able to transmit much in the way of material culture. A passing vessel which does not even anchor may be able to transmit iron, while European weapons may be used by people who have never even seen a white man. Again, missionaries introduce the Christian religion among people who can not speak a word of English or any language but their own, or only use such European words as have been found necessary to express ideas or objects connected with the new religion. There is evidence how readily language may be affected, and here again the present day suggests a mechanism by which such a change takes place. English is now becoming the language of the Pacific and other parts of the world, through its use as a *lingua franca*,

[13] There are definite exceptions in Melanesia; places where the social structure has been transformed, though the ancient language persists.

which enables natives who speak different languages to converse not only with Europeans, but with one another, and I believe that this has often been the mechanism in the past; that, for instance, the introduction of what we now call the Melanesian structure of language was due to the fact that the language of the immigrant people who settled in a region of great linguistic diversity came to be used as a *lingua franca*, and thus gradually became the basis of the languages of the whole people.

But now let us turn to social structure. We find in Oceania islands where Europeans have been settled as missionaries or traders perhaps for fifty or a hundred years; we find the people wearing European clothes and European ornaments, using European utensils, and even European weapons when they fight; we find them holding the beliefs and practising the ritual of a European religion; we find them speaking a European language often even among themselves, and yet investigation shows that much of their social structure remains thoroughly native and uninfluenced not only in its general form, but often even in its minute details. The external influence has swept away the whole material culture, so that objects of native origin are manufactured only to sell to tourists; it has substituted a wholly new religion and destroyed every material, if not every moral, vestige of the old; it has caused great modification and degeneration of the old language; and yet it may have left the social structure in the main untouched. And the reasons for this are clear. Most of the essential social structure of a people lies so below the surface, it is so literally the foundation of the whole life of the people that it is not seen; it is not obvious, but can only be reached by patient and laborious exploration. I will give a few specific instances. In several islands of the Pacific, some of which have had European settlers on them for more than a century, a most important position in the community is occupied by the father's sister.[14] If any native of these islands were asked who is the most important person in the determination of his life history, he would answer, "My father's sister," and yet the place of this relative in the social structure has remained absolutely unrecorded, and, I believe, absolutely unknown to the European settlers in these islands. Again, Europeans have settled in Fiji for more than a century, and yet it is only during this summer that I have heard from Mr. A. M. Hocart, who is working there at present, that there is the clearest evidence of what is known as the dual organization of society as a working social institution at the present time. How unobtrusive such a fundamental fact of social structure may be comes home to me in this case very strongly, for it wholly eluded my own observation during a visit three years ago.

Lastly, the most striking example of the permanence of social structure which I have met is in the Hawaiian Islands. There the original native culture is reduced to the merest wreckage. So far as material objects are concerned, the people are like ourselves; the old religion has gone, though there probably still persists some of the ancient magic. The people themselves have so dwindled in number, and the political conditions are so altered, that the social structure has also necessarily been greatly modified, and yet I was able to ascertain that one of its elements, an element which I believe to form the deepest layer of the foundation, the very bedrock of social structure, the system of relationship, is still in use unchanged. I was able to obtain a full account of the system as actually used at the present time, and found it to be exactly the same as that

[14] See *Folk-Lore*, 1910, XXI., 42.

recorded forty years ago by Morgan and Hyde, and I obtained evidence that the system is still deeply interwoven with the intimate mental life of the people.

If, then, social structure has this fundamental and deeply seated character, if it is the least easily changed and only changed as the result either of actual blending of peoples or of the most profound political changes, the obvious inference is that it is with social structure that we must begin the attempt to analyze culture and to ascertain how far community of culture is due to the blending of peoples, how far to transmission through mere contact or transient settlement.

The considerations I have brought forward have, however, in my opinion, an importance still more fundamental. If social institutions have this relatively great degree of permanence, if they are so deeply seated and so closely interwoven with the deepest instincts and sentiments of a people that they can only gradually suffer change, will not the study of this change give us our surest criterion of what is early and what is late in any given culture, and thereby furnish a guide for the analysis of culture? Such criteria of early and late are necessary if we are to arrange the cultural elements reached by our analysis in order of time, and it is very doubtful whether mere geographical distribution itself will ever furnish a sufficient basis for this purpose. I may remind you here that before the importance of the complexity of Melanesian culture had forced itself on my mind, I had already succeeded in tracing out a course for the development of the structure of Melanesian society, and after the complexity of the culture had been established, I did not find it necessary to alter anything of essential importance in this scheme. I suggest, therefore, that while the ethnological analysis of cultures must furnish a necessary preliminary to any general evolutionary speculations, there is one element of culture which has so relatively high a degree of permanence that its course of development may furnish a guide to the order in time of the different elements into which it is possible to analyze a given complex.

If the development of social structure is thus to be taken as a guide to assist the process of analysis, it is evident that there will be involved a logical process of considerable complexity in which there will be the danger of arguing in a circle. If, however, the analysis of culture is to be the primary task of the anthropologist, it is evident that the logical methods of the science will attain a complexity far exceeding those hitherto in vogue. I believe that the only logical process which will in general be found possible will be the formulation of hypothetical working schemes into which the facts can be fitted, and that the test of such schemes will be their capacity to fit in with themselves, or, as we generally express it, "explain" new facts as they come to our knowledge. This is the method of other sciences which deal with conditions as complex as those of human society. In many other sciences these new facts are discovered by experiment. In our science they must be found by exploration, not only of the cultures still existent in living form, but also of the buried cultures of past ages.

And here is the hopeful aspect of our subject. I believe our present store of facts, at any rate on the less material sides of culture, to form but a very small part of that which is yet to be obtained, and will be obtained unless we very wilfully neglect our opportunities. Waiting to be collected there is a vast body of knowledge by means of which to test the truth of schemes of the history of mankind, not only of his migrations and settlements, but of the institu-

tions and objects which have arisen at different stages of this history and developed into various forms throughout the world.

And this brings me to my concluding topic. I have tried to show that any speculations concerning the history of human institutions can only have a sound basis if cultures have first been analyzed into their component elements, but I do not wish for one moment to depreciate the importance of attempts to seek for the origin and early history of human institutions. To me the analysis of culture is merely the means to an end which would have little interest if it did not show us the way to the proper understanding of the history of human institutions. The importance of the facts of ethnology in the study of civilized culture is now generally recognized. You can hardly take up a modern work dealing with any aspect of human thought and activity without finding reference to the customs and institutions of savage or barbarous peoples. It is becoming recognized that a study of these helps us to understand much that is obscure in our own institutions or in those of other great civilizations of the present or the past. Further, there can be no doubt that we are only at the threshold of a new movement in learning which is being opened by this comparative study.

It is a cruel irony that just as the importance of the facts and conclusions of ethnological research is thus becoming recognized, and just as we are beginning to learn sound principles and methods for use both in the field and in the study, the material of our science is vanishing. Not only is the march of our own civilization into the hitherto undisturbed places of the earth more rapid than it has ever been before, but this advance has made more easy the spread of other destroying agencies. In many parts of such a region as Melanesia, it is even now only from the old men that any trustworthy information can be obtained, and it is no exaggeration to say that with the death of every old man there and in many other places there goes, and goes forever, knowledge the disappearance of which the scholars of the future will regret as the scholars of the past regretted such an event as the disappearance of the library of Alexandria. There is no other science which is in quite the same position. The nervous system of an animal, the metabolism of a plant, the condition of the South Pole, for instance, will a hundred, or even a thousand, years hence be essentially what they are to-day, but long before the shorter of those times has passed, most, if not all, of the lower cultures now found on different parts of the earth will have wholly disappeared or have suffered such change that little will be learned from them. Fortunately the need for ethnographical research is now forcing itself on the attention of those who have to deal with savage or barbarous peoples. Statesmen have begun to recognize the practical importance of knowledge of the institutions of those they have to govern, and missionary societies are beginning to see, what every wise missionary has long known, that it is necessary to understand the ideas and customs of those whose lives they are trying to reform. Still, we must not be content with these more or less official movements. There is ample scope, indeed urgent need, for individual effort and for nonofficial enterprise. It is not all who can go into the field and do the needed work themselves, but there are none who can not in some way help to promote ethnographical research. We have before us one of those critical occasions which must be seized at once if they are to be seized at all: the occasion of a need which to future generations will seem to have been so obvious

that its neglect will be held an enduring reproach to the science of our time.

W. H. R. RIVERS

THE NEW CHESTNUT BARK DISEASE

IN the latter part of the year 1904 Mr. H. W. Merkel discovered in the Bronx Botanical Garden a new and peculiar form of attack on the American wild chestnut tree, *Castanea dentata*. Prior to the finding of the cause of the infection, it had been noticed that this tree seemed to be in an abnormal condition.

A study of the infection was then undertaken and cultures were successfully made. It was determined, after its life history was better understood, that the attack was caused by a fungus, or a plant of fungoid nature, one of the Pyrenomycetes, a larger order of low-type plants, containing some of our most injurious fungi. The fungi in this order are known to attack not only other plants, but insects. Other well-known examples of this order of fungi are black knot of the plum and ergot of rye.

The chestnut blight has been identified by Professor Murrill as one of the genus *Diaporthe* named by him *parasitica,* and botanically described in *Torreya,* Vol. 6, No. 9, for September, 1906. Some doubt has recently been thrown about the genus to which it belongs. Because of its formation of ascospores within well-defined perithecia it is agreed that it rightfully belongs among the Pyrenomycetes. Its peculiar parasitic habit, however, is sufficient to cast some doubt upon the designation of the genus. No other well-known *Diaporthe* is parasitic. They are saprophytes. Because of its economic importance, almost vicious persistency and deadly habits with respect to its host, the wild chestnut, it might well be assigned to a new genus erected within the order. For a new generic name, the idea contained in the Greek Νικρωσις (nikrosis), a slaughtering unto extinction, would not be beside the fact.

The exterior appearance of this fungus first is numerous yellow pustules on the smooth bark of the tree. In the deep cracks of the oldest bark it takes the form of yellow or orange lines. Later the color turns to a much deeper yellow and finally brown of deepening shades. Within the pustules, the perithecia are found closely clustered, sometimes appressed. In outline they are not unlike the long-necked gourd, or a glass water-bottle. The walls of the neck of a perithecium are black, glistening, and, when cut across, have the sheen of anthracite coal. Within the perithecia are the elongated sacs or asci containing the spores, always eight in number, usually arranged in two rows, glassy and somewhat constricted across the short diameter. The largest of the asci will measure about 10×50 microns; the contained winter spores sometimes as much as 5×10 microns. Two forms of spores are found, as in many other fungi. The summer spores are produced in golden yellow threads protruded from the dome of the pustule, usually much twisted, and rarely found over a half inch in length. These summer spores, with dimensions not more than a fifth of those of the winter form, are exceedingly minute. By abrasion, action of rainfall, or other causes, they are scattered about continuously during the growing season.

It has been shown that the summer spores are of a sticky, gelatinous character. They are therefore peculiarly adapted to be carried about on the feet of insects, squirrels, or birds. Much of the heretofore inexplainable isolated spot infection must be attributed to such means of distribution, and less to wind action. But a spore covered with minute dust particles could just as easily be wind sown, as if it were originally of a scarious nature.

Entrance into a new host may be effected through slight wounds in the bark, broken twig ends or through insect tunnels, carried there by the insect itself. It was formerly believed that it entered only by these means. During the survey made along the main line of the Pennsylvania Railroad in the fall of 1910, by the Pennsylvania Department of Forestry, numerous instances were found where it seemed to have enacted through the lenticels of the bark, without insect aid or previous traumatism. It was also believed that the

fungus infects only the cambium of the bark and that the mycelium did not enter the cambium of the wood. During the survey just referred to, one well-defined instance was found where yellow pustules, plump and vigorous, *were growing upon freshly exposed wood.*

In this region the beginning of infection in a large number of cases was at a single point in the crown and in a few brown pustules in the deep cracks at the base of the tree. An exposed root running out horizontally for a foot or more was almost sure to contain pustules, no doubt washed down the stem by the rains, or brought by drip from neighboring trees with infected branches.

The appearance of the bark of a tree after an attack from this fungus is extremely characteristic. The bark will split, the surface within the lesion shows a sulphury-yellow tint, while numerous brown but minute wart-like excrescences will be found upon the unbroken bark surface. In the deep old bark cracks, it takes the appearance of reddish or orange-colored lines. The tendency of the disease is to encircle the branch or trunk. This produces another well-known mark, a depression or apparent sinking of the affected bark. In reality this is caused by the tree rushing nutriment to the spot and depositing it at the edges of the infected area, circulation being cut off within.

Another noteworthy fact respecting the life of this fungus is its great vitality. Unbarked chestnut rails made into fence and apparently well dried for a year or more have been found to contain active fruiting bodies. A pile of fence rails containing bark which was decayed to the point of falling from the wood by its own weight carried the blight in vigorous condition after two years. A specimen contained in a moist cell was found to be producing pustules after thirty-seven months. Just what amount of vitality will be retained by the dried spores and for how long is not definitely known. Certain it is, however, that the life within it is of unusual persistency and must be dealt with from that view point.

Prior to the year 1908 the chestnut bark disease was almost unknown in Pennsylvania. In the latter part of that year and in the early part of 1909, the attention of the Pennsylvania Department of Forestry was directed to its threatened invasion, by Dr. John Mickleborough, of Brooklyn, N. Y. Dr. Mickleborough pointed out the fact that the disease had probably entered the state and would continue its course westward were it not checked; also that it would be desirable to know to what extent it had entered Pennsylvania. Accordingly, the Deputy Commissioner of Forestry was detailed to accompany Dr. Mickleborough on a tour of inspection to determine the limits of the disease. This work was begun in the latter part of March, 1909, and was continued throughout that month and during the month of April, in which time many localities were examined. All of the southeastern counties of the state were inspected. At this time it was found that the main body of the disease was confined to the southeastern corner and that it had not crossed the north branch or the main river Susquehanna, except in the two instances discovered by the U. S. Department of Agriculture. Following this inspection, a report was prepared and printed, illustrated with drawings of the fungus in detail and accompanied by a print made by color photography, showing the appearance of the disease on living bark when developed to its fullest growth. Beside the articles appearing in botanical periodicals and the early reports of the U. S. Department of Agriculture, this report was the first to cover in detail any portion of country and the first report to be issued on the subject by any one of the states. Thus, within a short period, the disease developed from something unknown to a very decided and prominent attack upon one of the important wild trees of the commonwealth, and was rapidly extending itself to the western counties.

Somewhat prior to this time the officials of the Office of Forest Pathology in the U. S. Department of Agriculture were concerning themselves with its appearance in and around the city of Washington. They found it there rather numerously, and immediately applied the heroic remedy of cutting out and destroy-

ing every tree showing the infection. In this way it was possible to eradicate the disease for a distance of forty miles around the city, and to-day that area is believed to be almost if not quite free from infection. In this fact lies great hope, and it has a bearing of much importance upon future efforts to be made by any state for the eradication of the fungus.

As soon as its prevalence was proved in southeastern Pennsylvania, a determined sentiment arose looking to its destruction, or at least to staying its spread in such degree that it might not be communicated into new areas. Probably the worst infected portion of the state of Pennsylvania is that region along the main line of the Pennsylvania Railroad from the city of Philadelphia westward for a distance of fifty miles. The peculiarity of the infection in this region is that it seems to become more virulent the nearer one approaches the railroad, and is scattered in spots at distances therefrom. Whether this fact is sufficiently significant to point to railroad trains as vehicles of distribution, possibly remains to be proved; but it is a fact worthy of careful attention.

Along this portion of the railroad there exists a civic body known as The Main Line Citizens' Association, banded together for the good of the neighborhood. The chestnut tree forms a large proportion of all the wooded areas in this locality and is one of the best park, woodlands and lawn shade trees of natural growth in that region. Realizing that serious trouble has come upon the chestnut trees, this association appointed a committee to inquire into the trouble; and in the spring of 1910 this committee entered into negotiations with the Pennsylvania Department of Forestry for the purpose of making a proper inquiry into the situation. The result of the maturing of their plans was that a corps of inspectors consisting of foresters, students in forestry, and draftsmen, under the direction of the Deputy Commissioner of Forestry, located themselves at Ardmore in the midst of the infected region, and immediately began a detailed survey of the neighborhood hereinabove referred to, for the purpose of determining to what extent the disease had attacked the trees, and making report thereon. This work was continued throughout the fall and closed in the early part of December, with the coming of freezing weather. The plan adopted was to take a rough preliminary draft of each tract upon the ground. The approximately correct location of every chestnut tree on the premises was indicated on the draft and designated by numbers corresponding to a number upon a small wooden tag attached to the tree. At the same time a careful examination of the tree was made and a report noted in record books carried for the purpose, of the condition of the trees, showing the presence or absence of the infection, and in what portion of the tree it existed most prominently. The rough draft finished, it was returned to headquarters, re-drafted with care and accuracy upon tracing cloth, and blue prints made therefrom. A print together with a detailed report on the condition of the trees was then sent to each property owner. This gave him an accurate key to the situation, and it remained for him to decide what to do with respect to treatment, cutting the trees, or whatever else might seem to be called for. In this way nearly 300 properties were examined and reported upon, ranging in size from small town lots to areas of hundreds of acres. Over 30,000 tree groups, representing over 50,000 tree stems, were examined, reported upon, and recommendations relating thereto made to the owners. To prove that The Main Line Citizens' Association was really in earnest, it should be stated that they collected and expended for this work nearly $3,000, and the cooperation of the Department of Forestry represented an expenditure in time nearly equal in value to the expense of the committee.

The committee having this work in charge and representing the association consisted of the following gentlemen, property owners and residents in the immediate neighborhood: Harold Peirce, of the New York Life Insurance Co., chairman; Allen Evans, architect; Theodore N. Ely, superintendent of motive power of the Pennsylvania Railroad; Edgar

C. Felton, president of the Pennsylvania Steel Co.; Wm. Righter Fisher, attorney at law, of the Philadelphia bar; Alba B. Johnson, vice-president, Baldwin Locomotive Works; Robert W. Lesley, president of the American Cement Co.

When the work of inspection had proceeded, it was seen that the infection was of great extent, averaging more than fifty per cent. of all the trees examined. Under these conditions individual and unsystematic effort would and probably could avail but little against the progress of the infection. It was decided that the aid of the government should be called in to render the necessary assistance. The Department of Forestry of the state of Pennsylvania was without direct legislative authorization to do work of this character on a state-wide scale, and without appropriation if it had the authority. The national government was appealed to and word came back that the appropriation bills were all drawn, had passed the house of representatives and were on their passage through the senate, with little or no prospect of change or increase in appropriation. However, the active interest of Senator Penrose was enlisted, and an amendment was added by him in the senate to the agricultural appropriation bill, carrying $5,000 for the purpose of further study and investigation of this tree disease; and in the very last hours of the session, which ended March 4, 1911, the amendment was agreed to by both houses and shortly thereafter became a law by the signature of the president. Thus, it will be seen that through the activities of the committee representing the above association there was accomplished what at first seemed almost hopeless. With this success in mind, the committee and their friends and Pennsylvania state officials familiar with the situation turned to the legislature, then in session, for help and legislative authority to attack the problem in Pennsylvania. The governor of the commonwealth sent an urgent message to both houses of the legislature, a bill was introduced simultaneously in both, was passed without debate or a negative vote, and became a law by the signature of the governor, June 14, 1911. The same phenomenal good fortune attended this effort, and the law itself is looked upon as marking a great epoch in work of this kind. It provides for the creation of a commission of five persons, confers complete authority to attack and destroy this disease by whatever method they may adopt, and appropriates $275,000 for two years for the purpose of carrying on this work. The commission, only recently appointed by the governor, consists of the following persons: Samuel T. Bodine, Villa Nova, vice-president and general manager of the United Gas Improvement Co.; George F. Craig, Rosemont, wholesale lumber dealer and large lumber operator; Theodore N. Ely, Bryn Mawr, former superintendent motive power, Pennsylvania Railroad Co.; Harold Peirce, Haverford, of the New York Life Insurance Co.; Winthrop Sargent, Bryn Mawr, former president Standard Supply and Equipment Co.

The commission has effected an organization by choosing Mr. Sargent chairman, Mr. Peirce secretary, and Mr. Samuel B. Detwiler, a Minnesota forester, but a Pennsylvanian by birth, executive officer to have full charge of the work. Permanent offices have been secured in the Morris Building, Philadelphia.

In order that valuable time might not be lost while the organization was being perfected, the Department of Forestry of the state organized the outside work by sending men first to an instruction camp and then starting them out as scouts in lower York County, to locate infection and report on its prevalence.

Reports from these parties are now being received daily. With additional parties organized, York County will soon be covered and the work will then continue up the west side of the Susquehanna River and westward along the Maryland line. A large amount of preliminary work will be done this year in the hope that the winter work of taking down infected trees may accomplish the desired end, preventing further westward spread of the infection.

I. C. WILLIAMS,
Deputy Commissioner of Forestry of the State of Pennsylvania

THE SCHOOL OF AMERICAN ARCHEOLOGY

THE School of American Archeology, organized in 1907 under the act of incorporation of the Archeological Institute of America, held during the month of August a summer session in the Palace of the Governors at Santa Fé, the headquarters of the School, and at the Excavation Camp in El Rito de los Frijoles, where the school has conducted excavations for the past three summers.

The work consisted of examination and study of the communal house, cliff dwellings and the ceremonial cave of this deserted Pueblo, excavated in former seasons, and of lecture courses intended to give to regular students and auditors a view of the general field of archeology.

Director Hewett gave a series of peripatetic lectures on the excavations already made and in progress and on the culture of the Pajaritan plateau as revealed by them; Mr. Chapman, of the staff of the school, lectured on the development of design in ancient Pueblo pottery, and Mr. Harrington, also of the staff, lectured on the language, social organization, religion and mythology of the Mohave Indians, presenting results of his recent field work in the Colorado basin.

In addition to these courses in American archeology, Professor Frank E. Thompson, of the University of Colorado, gave ten lectures on primitive man and the evolution of culture; Professor Mitchell Carroll, general secretary of the institute, gave a series of lectures on Greek archeology with special reference to the excavations in Greek lands conducted by the institute and school at Athens; and Professor Lewis B. Paton, of Hartford Theological Seminary, lectured on the ancient Semites, discussing the primitive Semitic life, literature, art, religion and social organization.

A series of Sunday-evening lectures was given in the Hall of Representatives in the capitol, as follows: "Jerusalem in the Time of Christ," by Dr. Paton; "The Holy Cities of Ancient America," by Dr. Hewett; "The Early History of Christianity," by President E. McQueen Gray; "Paul at Athens," by Professor Carroll.

The excavations of the present season in the Rito were confined largely to clearing the old elliptical communal dwelling in the valley, the excavation of which was more than half completed last summer. The attendance upon the summer session was very good, about fifty being regularly enrolled.

The managing committee of the School of American Archeology held its annual meeting in connection with the summer session, August 24–26. Alice C. Fletcher, of Washington, D. C., was reelected chairman; the office of vice-chairman was created, and William H. Holmes was elected. Standing committees were appointed on finance, the museum and the scientific and educational work of the school. Director Hewett reported on the excavations conducted during the past year at Quirigua in Guatemala, on the research work of members of the staff and the summer session. Plans were formed for the conduct of the excavations in New Mexico and Central America during the coming year, and for the holding of a second summer session in August, 1912.

APPROPRIATIONS MADE FOR SCIENTIFIC PURPOSES AT THE PORTSMOUTH MEETING OF THE BRITISH ASSOCIATION

Section A—Mathematical and Physical Science

Seismological Observations	£60
Upper Atmosphere	30
Magnetic Observations at Falmouth	25
Establishing a Solar Observatory in Australia	50
Grant to the International Commission on Physical and Chemical Constants	30
Tabulation of Bessel Functions	15

Section B—Chemistry

Study of Hydro-aromatic Substances	20
Dynamic Isomerism	30
Transformation of Aromatic Nitro-amines	10
Electroanalysis	10
Plant Enzymes	30

Section C—Geology

Erratic Blocks	5
Paleozoic Rocks	10

Composition of Charnwood Rocks	2
Igneous and Associated Sedimentary Rocks of Glensaul	15
List of Characteristic Fossils	5
Sutton Bone Bed	15
Benbridge Limestone	20
Section D—Zoology	
Index Animalium	75
Table at the Zoological Station at Naples	30
Belmullet Whaling Station	20
Secondary Sexual Characters in Birds	10
Section E—Geography	
Equal Area Maps	20
Calculation of Areas on the Spheroid	25
Section G—Engineering	
Gaseous Explosions	60
Section H—Anthropology	
Glastonbury Lake Village	5
Age of Stone Circles	15
Anthropological Notes and Queries	40
Artificial Islands in Highland Lochs	13
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Structure of Fossil Plants	15
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Total	£1,050

SCIENTIFIC NOTES AND NEWS

At the meeting of the corporation of Yale University on September 18, Sir William Osler, regius professor of medicine at Oxford, was appointed Silliman lecturer for 1912, and Dr. Joseph P. Iddings, until 1908 professor of petrology in the University of Chicago, and now engaged in geological research, was appointed lecturer for 1913.

Dr. Simon Flexner, director of the laboratories of the Rockefeller Institute for Medical Research, has been awarded the Cameron Prize in practical therapeutics by the University of Edinburgh in recognition of his work in cerebrospinal meningitis. In accordance with custom Dr. Flexner has been invited to deliver an address at the University of Edinburgh during the coming academic year.

The *Journal* of the American Medical Association notes that the tenth volume of the *Archiv für Orthopädie* is dedicated to Gustav Zander on the occasion of his seventy-fifth birthday. The first nine articles describe Zander's work and apparatus for medico-mechanical exercises and the opening of his institute at Stockholm, Sweden, in 1865 and of similar institutions on this model in other countries. The benefits of these mechanico-therapeutic exercises in the various internal infections are emphasized by different authors. From 1880 until recently Zander was docent of medical gymnastics at the University of Stockholm.

The Belgian Academy of Sciences has elected as foreign members Professors Emil Fischer and Simon Schwendener, of Berlin, and Professor J. Pawlaw, of St. Petersburg.

As a memorial to Noah Porter, formerly president and professor of philosophy at Yale University, it is proposed to erect a gate at the south end of University Avenue at a cost of $18,000.

Dr. Jacques Hadamard, professor of analytical and higher mechanics in the University of Paris, will give at Columbia University during the month of October courses on the calculus of variation and partial differ-

ential equations of physics. In addition he will give four general lectures on Saturday mornings at 10.30 A.M., as follows:

October 7—"The Definition of Solutions of Linear Partial Differential Equations by Boundary Conditions. How is the Problem to be Set?"

October 14—"On the Recent Applications of certain Mathematical Theories to Physical Problems: Ordinary Differential Equations, Integral Equations, Integro-differential Equations, etc."

October 21—"Analysis Situs, its Rôle in several Mathematical Questions, especially in Finite Correspondences and Differential Equations."

October 28—"Elementary Solutions of Partial Differential Equations and Green's Functions, with Especial Attention to the Latter."

PROFESSOR O. P. HOOD, head of the department of mechanical and electrical engineering at the Michigan College of Mines, has been appointed chief mechanical engineer of the Bureau of Mines with headquarters at Pittsburgh, Pa.

DR. DANIEL W. FETTEROLF has resigned as demonstrator of chemistry and toxicology in the University of Pennsylvania, to accept the position of acting assistant surgeon in the U. S. Army, with a permanent station in New York.

PROFESSOR FREDERICK STARR, of the University of Chicago, whose anthropological studies have covered Mexico, Japan and the Kongo, sailed from Seattle in August for Korea, where he will spend the next few months.

MR. GEORGE GARNERHAS arrived in this country from the French Congo, bringing with him for the New York Zoological Park a female gorilla, about eighteen months old. It is said to be the second gorilla which has reached this country alive.

SIR CLEMENTS R. MARKHAM has been selected president of the eighteenth International Congress of Americanists, to be held in London beginning on May 27, 1912. Applications of membership in the congress and titles of papers should be sent to the secretary, F. C. A. Sarg, Esq., Royal Anthropological Institute, Great Russell St., London.

THE British Association for the Advancement of Science at its Portsmouth meeting, constituted a new section devoted to agricultural science, to be known as Section M.

THE thirty-second meeting of the Society for the Promotion of Agricultural Science, will be held at Columbus, Ohio, on Tuesday, November 14, 1911, immediately preceding the convention of the Association of American Agricultural Colleges and Experiment Stations. Headquarters will be at the Great Southern Hotel, where the sessions will probably be held.

A CALL has been issued by President Seth Low of the National Civic Federation for a meeting of the new Pure Food and Drug Department of the federation, which will be held in the rooms of the New York Board of Trade and Transportation on Monday, October 2. Among the speakers will be Dr. Harvey W. Wiley, chief of the Bureau of Chemistry; Dr. Thomas Darlington, ex-Commissioner of Health for the city of New York, and Dr. William C. Woodward, secretary of the American Public Health Association.

FOREIGN journals state that a special commission was recently appointed to study the utilization of aeroplanes for ensuring rapid communication with districts of the Belgian Congo that are still unprovided with railways and roads, and that it has been decided to await the results of certain tests to be carried out in France. Attempts will be made to traverse a desert about 750 miles across, and to establish landing stations 250 miles apart, fitted with wireless telegraphy. The aeroplanes will have to convey three passengers and a relatively heavy load of victuals, water, tools, etc. It is hoped that this line will be established in 1912. A first subsidy of $80,000 has been voted for the establishment of these communications.

A COMMITTEE dealing with the hygienic aspects of illumination has been appointed by the minister of the interior in France. The objects of the committee include the general effects of illumination on health, the framing of simple rules as to the best means of applying customary systems of lighting to various industrial operations, the nature and causes of

short sight and impairment of vision, and their connection with defective living conditions, the study of methods of measuring illumination, etc.

We take from the *Geographical Magazine* some details in regard to the Antarctic expedition of Dr. Douglas Mawson, who left London for Australia in June and is now completing the arrangements for the final departure of his expedition from Hobart before the close of the year. As promised to Dr. Mawson before he left England, a treasury grant of £2,000 towards the expenses of the expedition has been provided for; the Australian Commonwealth Government has made a grant of £5,000. His ship, the *Aurora,* which was built at Dundee in 1876, arrived in the Thames from Newfoundland in June, and was placed under the command of Captain J. K. Davis. After undergoing extensive alterations, she sailed from the West India Docks on July 27, was "swung" for the adjustment of her compasses under the direction of the Admiralty officials at Sheerness, and then proceeded to Cardiff to take on board supplies of coal, finally leaving these shores on August 4, bound for Cape Town and Hobart. She is a roomy vessel of her class, a little smaller than the *Terra Nova,* her dimensions being—length over all, 165 feet; breadth, 30 feet; depth, 18 feet; gross register, 580 tons. She is fitted with a compound engine of 98 nominal horse power, and is capable of a speed of 9 knots an hour. A new multitubular boiler was put into her in 1905, and under steam she consumes 11 tons of coal a day. For sailing purposes in the Antarctic seas, her rig has been altered from that of a schooner to that of a barquentine. The accommodation aft has been remodeled, so as to serve the requirements of the large scientific staff she will carry from Hobart to the shores of the Antarctic continent. Other alterations include the erection on deck of a biological and a general laboratory. Most of the staff will join in Australia, the only members sailing from England in the *Aurora*—besides the ship's officers—being Dr. Mertz, a Swiss zoologist, who is an experienced mountaineer, and who won the Swiss ski-jump championship in 1908; and Lieutenant Ninnis, Royal Fusiliers, who will take part in the survey work. At the request of the Prince of Monaco, who has provided the expedition with its oceanographical equipment, Dr. Mertz went through a special course of training at the Monaco Océanographical Laboratory and on board the *Princesse Alice.* A valuable equipment for magnetic work has been lent by the Carnegie Institution of Washington. The *Aurora* carried, when she left England, forty-eight Greenland dogs, obtained through the kindness of the Danish Government, and a large number of Norwegian-built sledges, as well as the bulk of the stores and food supplies for the three parties which it is hoped to land between Cape Adare and the Gaussberg.

According to the London *Times* a departmental committee consisting of Mr. Angus Sutherland, C.B., chairman, Mr. J. E. Sutherland, M.P., Mr. H. M. Conacher, Dr. T. Wemyss Fulton and Mr. J. Moffatt, has been appointed by the Secretary for Scotland to inquire into and report upon the character and national importance of the inshore and deep-sea fisheries of Norway and other countries engaged in the North Sea fisheries, and the efforts made for the development of the fishing and fish-curing industry in all its branches, including (1) the systems of fishery administration, including the constitution and function of the local committees formed for this purpose in Norway and of any similar organizations in the other countries; (2) the facilities provided for research and for educating and training those engaged in these industries, by the establishment of technical schools, museums, laboratories, classes or other special facilities; (3) the nature of the various means of capture employed and the methods (including any use of state credit) by which fishermen obtain the necessary capital to maintain the efficiency of their vessels and equipment; and to report in regard to each of the foregoing matters whether it would be advisable for similar action to be taken, with or without modifications, in the

case of the Scottish fishing industry, and, if so, what means should be adopted.

UNIVERSITY AND EDUCATIONAL NEWS

At the University of Pennsylvania Dr. R. M. Pearce has withdrawn from the chair of pathology and will confine his work to the chair of research medicine, and Dr. Allen J. Smith returns to the charge of the department of pathology, retaining at the same time the directorship of the laboratories of comparative pathology and tropical medicine.

Dr. J. H. Clo, of the University of Chicago, has been appointed to the chair of physics in Tulane University.

Dr. Howard T. Karsner, demonstrator of pathology in the University of Pennsylvania, has been appointed assistant professor of experimental pathology in Harvard University.

At the University of Maine, Dr. M. A. Chrysler, professor of botany, has been appointed head of the department of biology to succeed Dr. G. A. Drew, and Mr. H. M. Parshley has been appointed instructor in zoology.

Dr. Fraser Harris, at present lecturer on physiology in the University of Birmingham, has been appointed professor of physiology in the Dalhousie University, Halifax, Nova Scotia.

The appointment of lecturer and demonstrator in the physical department of the East London College, vacant by the resignation of Mr. E. Marsden, M.Sc., on his election to the John Harling Research Fellowship at the University of Manchester, has been accepted by Mr. T. Harris, B.Sc., of the Imperial College of Science and the Cavendish Laboratory, Cambridge. Mr. Harris has been engaged in advanced research work under Professor Sir J. J. Thomson.

DISCUSSION AND CORRESPONDENCE

"WASHINGTON SCIENCE"

The phrase which heads this communication appears now and then in print and may be assumed to have a depreciatory significance, whether this is due to a mistaken estimate of the quality of research work done in that city under governmental supervision; or with a feeling that scientific men so employed have what in college slang is termed a "soft snap"; or to a vague impression that a man willing to accept government employment must necessarily be a lower order of being in his general class, or to all these ideas combined in varying proportions—can not be decided here. But it occurs to me that the experience of one who has spent nearly half a century in scientific work, under government auspices, might throw some needed light on the subject for those without similar experience.

It is to be premised that scientific men differ like other men in their temperaments, breadth of view and social training. Their interest in and devotion to a particular line of research does not divest them of the common frailties of mankind, whether in Washington or elsewhere. In the history of American science, the three least creditable and most bitter controversies which have affected the relations of scientific men were between scientists of a high order, not Washingtonians.

Civil service reform has changed for the better in many ways the conditions confronting those desiring to enter the service of the government. Yet the writer entered that service at a time when no such reform had been instituted, and from the first day to this date has never been asked what his politics were or requested to secure "influence" to maintain his position or obtain promotion. The fact that he was believed to possess certain qualifications for his work and has conducted it since appointment in a satisfactory manner has covered the whole ground.

So far as the writer knows, barring the changes due to civil service reform laws, this experience is not exceptional.

We hear much about "red tape" as an obstacle to efficient work. Now "red tape" means fundamentally the fixing of responsibility. This may be either financial or other. The uninformed critic does not realize that the function of "red tape" is reciprocal, that

it not merely protects the government, but the individual whose service is governed by it, and whose devotion to a special object might in many cases without such wholesome restraint lead him to forget that he must keep step with his colleagues. Furthermore, "red tape" is not merely a governmental device, but is universal in all large organizations, private or public, and so far as the writer's observations extend, is, if anything, more rigid in private practise. No college, corporation or organized service is without it, and the occasional abuse of its restrictions is as common in these bodies as in the government service.

The features of "red tape" which are occasionally injuriously restrictive in government work are almost invariably due to the well meant but hasty desire of some "reformer" in congress who has discovered some supposed laxity in the public service and, desiring to make it impossible for the laxity to continue, procures the enactment (always easy) of some iron-clad restriction upon the action of public servants. After congress has adjourned the executive legal officers find that the language of the act is so broad that it covers proceedings never intended to be affected and entirely foreign to the supposed abuse it was intended to correct. Fortunately such blunders are less common than of old. "Pure ignorance, ma'am," as Dr. Johnson said, and certainly not to be charged to the account of science, Washington or other.

There is a very large class of employees in government service, in the wide sense, who are merely clerks and who are very much like clerks outside of the service, except that they have to live in a city where their easy hours and generous vacation hardly make up for its humid heat and excessive cost of living.

The great majority of these clerks do a fair day's work, but there were in past years enough of the element owing their position to "influence," and therefore more or less independent of their superiors in office, to give the service a bad name, which will probably endure a long time after such conditions have become merely a memory.

In the scientific corps if I may term it so, we have a body of men who for the most part seek and keep their positions for the wide opportunity for research the government work offers.

Few of them would be able to remain if they had not some private income additional to their inadequate salaries. The pay averages about that of the second-rate colleges, without the opportunity for economy and plain living without loss of social standing, which most colleges afford.

The cost of living in Washington has considerably more than doubled since the writer's residence began. When to decent clothing, food and shelter required by one's surroundings are added the care and education of a family, the subscriptions to a few periodicals and societies absolutely necessary to a scientific man, it is certainly not without personal sacrifice that the majority of the corps stand their ground.

Nor among the leaders is there cause for criticism in the matter of their devotion to science. Time and again have men fallen by the wayside, victims of voluntary overwork and nervous strain, which took no note of official hours or vacations. Every Washingtonian man of science knows of such men and honors their memory.

As to the quality of work turned out, it speaks for itself and is in no need of eulogy.

It is true that certain bureaus have fallen into evil times, for which we have to thank chiefly the late Mr. Cleveland's scorn of scientific men. One of them has become little more than a pasture for politicians, but nearly all its scientific workers have deserted it and its publications of a scientific character in the main are the work of men outside the service.

In this, as in less notorious cases, the just criticism that may be made should have for its basis not Washington science or Washington scientific men, but the ignorance of legislators and the indifference of politicians and the public.

The men of science, not of Washington,

have more or less responsibility resting upon them for whatever may be properly criticized in the governmental scientific corps. Efforts the corps itself may make for betterment are liable to the charge of self interest. The "outsiders" can help, if they will, to promote the ideal service. For such help no one will be more grateful than the members of the corps concerned.

A long dissertation illustrative of the statements above made might easily be written, but space requirements forbid it here.

In conclusion the writer is confident that neither in this country nor elsewhere is to be found a body of men of science more devoted to their work, more self-sacrificing in their devotion to it, and with a more honorable record, than the scientific corps of the government service, however, in the human way, it may fall short of the ideal.

WASHINGTONIAN

"BIOLOGY"

TO THE EDITOR OF SCIENCE: The publication in SCIENCE, of September 8, 1911, of a request that you "refuse to print any communication in which the adjective 'due' appears in any way except as agreeing . . . with some noun or pronoun" leads me to refer to the advertisement on page 1, of the same number, which gives, under six heads, a list of educational books for sale, one of the heads, "Biology," listing texts on "Laboratory Zoology," "Mammalian Anatomy" and "Zoology"; another head is "Botany," listing a "Guide to Laboratory and Field Studies," "Plant Anatomy" and "Vegetable Physiology."

After we have decided what the difference is between water-vapor and steam, and why the ether can not be made of electrons, will you please allow space for replies to the following question: What is there more "biological" about laboratory zoology than about laboratory and field studies in botany, about mammalian anatomy than about plant anatomy, or about a text-book on zoology than one on vegetable physiology?

Will not SCIENCE hereafter please refuse to publish any communication or advertisement in which the word biology is used as synonymous with zoology? Zoological journals please copy!

C. STUART GAGER

BROOKLYN BOTANIC GARDEN,
September 11, 1911

HOUSE AIR

TO THE EDITOR OF SCIENCE: Before the last echoes of the discussion as to indoor and outdoor air, humidity and so on die away I should like to add a word as to the general neglect on the part of doctors and nurses to look carefully into the nature of the air supply. There is an increasing tendency to prescribe life out of doors, even in bad weather, as almost a specific for many pathological conditions, from incipient tuberculosis to weak heart action. But after all, most sick people are indoors during the greater part of the twenty-four hours, at most seasons of the year. And yet it is rare indeed to find even an exceptionally intelligent physician who knows in detail at what rate the air of the patient's room is being changed, what is its origin, or its relative humidity. Physicians rather commonly and nurses almost always ignore the difference in ventilating effect between furnace or indirect steam heating and hot water or steam pipes in the rooms of the house. I have heard an unusually intelligent nurse, a woman with years of thorough training in her calling, argue for a half hour that no change of air could be accomplished by an open furnace register—she doubted whether any air came into the room from that source at any time.

As a matter of fact the ventilation from a register of ordinary size (say $9\frac{1}{2} \times 15\frac{1}{2}$ inches) in freezing weather, with a reasonable fire in the furnace, is much better than can ever be obtained in summer by opening a single window to its full height. There is no other simple way of securing cold weather ventilation in ordinary houses so certain to act efficiently as heating with a furnace provided with a capacious cold air duct. Still

this source of air supply leaves much to be desired on the score of quality. Much street dust may enter the cold air box and be distributed throughout the house. And few realize the parching quality of the air in furnace heated houses. I have found the air in a house heated by a good furnace in moderately freezing winter weather in Massachusetts with a relative humidity as low as 16 per cent. This, too, was with the water reservoir of the furnace well filled. Such air is far dryer than that of an oasis of the Sahara in the driest season of the year and it irritates the skin and mucous membrane and carries off moisture so rapidly in insensible perspiration as to make it necessary to maintain the room temperature at a point several degrees higher than would otherwise be demanded.

Furnace heating may be made to furnish much better air for breathing by straining the air, either by means of a thin layer of cotton batting at the entrance of the cold air box or by a layer of the silk-like glass fiber, used for jacketing steam pipes and so on, under each register. The humidity may be considerably increased by supplying boiling water to the evaporating reservoir in the furnace. In single rooms it may be raised by keeping a large coarse towel, frequently wrung out, hung from any convenient support immediately over the register. Where there is a combination of steam and furnace heating, the hot air may be moistened to any desired extent by letting a very minute steam jet enter the heated air inside the outer jacket of the furnace.

Whatever the nature of the heating apparatus employed, the householder of inquiring mind will find a good deal of food for reflection in the results obtained by burning touch-paper just over the registers or radiators which serve as the source of heat and watching the distribution of the heated air and by measuring the relative humidity of the air in some living rooms in cold weather, by means of a sling psychrometer. The values corresponding to the readings of the wet bulb and dry bulb thermometer can be obtained by inspection of the "Psychrometrical Tables" published by the U. S. Department of Agriculture, Weather Bureau.

J. Y. Bergen

Cambridge, Mass.

ELEMENTARY TEXT-BOOKS IN CHEMISTRY

To the Editor of Science: Professor Miller in his address given at Indianapolis and published in No. 870 of Science criticizes in some important particulars the current elementary text-books in chemistry. Personally I would have been better pleased with the excellent and timely address if he had said "many text-books," or "most text-books," instead of "our text-books." It should also be said that an elementary book ought rather to be conservative than radical, as long as the conservative position has a considerable following among leading chemists.

The particular criticisms offered by Professor Miller suggest the general subject and lead me to speak of one or two others, which I confess do not apply to all elementary texts. Passing by criticisms that are often made—as that many books are too learned and heavy in style, that they make too much of chemical theory and do not show respect enough for chemical fact, etc.—I want to say a word concerning the immense field that the usual book presents to the high school student, to be completed in one year. I do not refer to the size of the book but the amount of matter. Some of the smaller books sin worst in this regard, being little more than a synopsis of a good college book. I know how much can be said in favor of a complete view of an important subject of study, and how much about the vital character of any particular suggested omission, but there is one sort of reduction that might easily be secured. This large field has grown of recent years partly by annexing outlying territory that was formerly regarded as belonging to other subjects of study. Many elementary books are written fully in the spirit of a sentence which I quote from a recent address on chemistry: "Physics, geology, engineering, physiology, botany, zoology and

biology are subdivisions of the broader science of chemistry." Should it not be possible to find a core of this work which is essential chemistry and teach that?

The physics people have met the challenge concerning boundaries and disputed territory courageously. It is not long since I heard a university professor begin a lecture on physics somewhat in this way: "Physics is the science of matter and energy. This field is so large that it is customary at present to break off the physics of the molecule and its reactions and call it chemistry. Also to put to one side the physics of the heavenly bodies and call this part astronomy," etc. So these two subjects, physics and chemistry, have been mutually devouring each other, like two Kilkenny cats, lo these many years. It seems to have been good for them, however, for both have grown to be lusty fellows. The only difficulty seems to be to determine which is which. Suppose we give up trying, call the amalgamated science what you like, and frankly make a two-years course in this science, with the topics arranged in logical order, as an elementary book for high schools. This would dispose of the not very important but still much discussed question whether chemistry should come in the eleventh or the twelfth year, as well as the far more important matter of extensive duplication. At first sight it might seem desirable to repeat a large amount of physics in the chemistry classes, especially as this part is in general very important, but a moment's thought will convince any one—not already convinced by experience—that this is not likely to be true. The work presses; the class will meet these subjects elsewhere; nobody is responsible for a full presentation of them; and so the few ideas most essential to further progress are made to suffice. There is no one to apply the excellent homestead law—one must not only stake out a field but occupy and do some work upon it.

If a two-years' unitary course in physical science can not be secured, some competent authority—say a joint committee of the chemical and physical societies of America—might be asked to say what shall be taught as chemistry and what as physics. For instance, where shall the modern doctrine of solutions be taught? How much of combustion, of electrolysis, of the action of a primary battery, is chemistry and how much physics?

E. A. STRONG

SCIENTIFIC BOOKS

Physical Optics. By ROBERT W. WOOD, LL.D., Professor of Experimental Physics in Johns Hopkins University. Second Edition. New York, The Macmillan Company. 1911. Pp. xvi + 705. Price $5.25 net.

To those who are acquainted with the earlier edition of Wood's "Physical Optics" it will be high and just praise of the second edition merely to say that it is vastly superior to the first. The new material added to the former discussion—roughly, fifty per cent.—illustrates the tremendous recent development of physical optics; and the manner in which all this work is described continues to illustrate the extraordinary clarity and precision with which intricate matters may be set forth, in a non-mathematical way, by a man who really and profoundly understands his subject.

Of the various additions and improvements, perhaps the following will serve to characterize the whole:

The first three chapters have not been much altered, although they do contain some new material, such as the work of Galitzin and Wilip on Döppler's principle, Pfund's mercury arc, etc.

A very characteristic addition finds place in the fourth chapter, the one dealing with refraction, where a series of photographs taken with a lens immersed in water—a "fish-eye camera"—has been inserted. These give a concreteness and directness to the treatment of the critical angle which could hardly be obtained in any other manner.

Chapter V., on dispersion, shows few changes, but is enriched by a plate showing Julius's remarkable series of photographs of the "D" lines, under various physical circumstances.

The value of the chapter on diffraction is

enhanced by an exposition of A. B. Porter's work on the nature of optical images, by the author's clever vectorial treatment of secondary maxima in grating spectra, by an account of the Echelette grating, and by a new viewpoint from which to regard Talbot's fringes —all of which have recently appeared in the *Philosophical Magazine.* The discussions of interference and polarization remain almost intact. A brief but entirely new chapter is here given to "Meteorological Optics."

The beautiful method of focal isolation by which Rubens and Wood have recently been enabled to measure heat waves which are more than one tenth of a millimeter in length, has been inserted in the chapter on the theory of dispersion. But this well illustrates the impossibility of keeping a treatise up to date; for notwithstanding the preface is dated May, 1911, the infra-red spectrum has since then been extended more than an octave and a half; so that now the gap between the electrical and optical spectra is something less than three octaves—the difference between a third of a millimeter and two millimeters.

Interesting additions, dealing with the absorption of gases, have been made to Chapter XV., including Wood's extension of Balmer's series for sodium vapor absorption lines to the 48th member.

The discussion of magneto-optics has been greatly and properly enlarged, and is followed by an entirely new chapter on electro-optics.

Chapter XX., dealing with fluorescence and related phenomena, has a long title of nine words which, in the opinion of your reviewer, might well be replaced with the single term "Photo-luminescence." The Laws of Radiation (Ch. 21) have been made to include the recent achievement of Lebedew in demonstrating experimentally that a beam of light exerts a definite pressure upon an absorbing gas.

The remainder of the volume differs little from the former edition except that a final chapter on the principle of relativity has been added. But to attempt an elementary exposition of the ideas of Einstein and Minkowski in twelve small pages is well nigh attempting the impossible. Lack of consecutiveness makes this last chapter the only unsatisfactory one in the entire volume.

Of the book as a whole it ought to be remarked that it teems with practical hints of great value, clever bits of experimental experience from the large fund for which the professor of experimental physics in Johns Hopkins University is justly celebrated. The policy of the author in maintaining a quantitative discussion throughout, and yet refraining from the use of very advanced or severe or complicated mathematical methods, is to be highly commended. It is a matter of constant surprise to find what a large proportion of all really important phenomena can be described by very simple differential equations and can be discussed by the ordinary analysis. This remark is, of course, only intended to apply to the mathematical method of a treatise for students of physics, and not to an original paper describing the results of a mathematical investigation.

A work so altogether admirable as this should not be marred by so many typographical errors and incomplete references. Sometimes one is referred merely to "*Phil. Mag.*," at other times, as for instance in Runge's exquisite treatment of the concave grating, p. 233, one is merely told that the discussion is "due to Runge." Economy of energy on the part of the reader will be greatly served by the correction of many of these slight matters in a future revision.

However views may diverge as regards the treatment of various topics in this volume, there can surely be no difference of opinion among English-speaking students as regards the generosity which Professor Wood has shown in taking time and energy from a strenuous life of research to prepare this clear, scholarly and thoroughly modern treatise. Appreciation of this can hardly fail to show itself in a long and wide-spread use of the book.

HENRY CREW

Atlas of Zoogeography. By J. G. BARTHOLOMEW, W. EAGLE CLARK and PERCY H. GRIMSHAW. Series title: *Bartholomew's Physical*

Atlas. Volume V. 46.5 cm. Published under the patronage of the Royal Geographical Society, Edinburgh. 1911.

This handsome folio contains a limited text and "a series of maps illustrating the distribution of over seven hundred families, genera and species of existing animals." The text is divided as follows: I., General Principles of Distribution (2½ pp.); II., Historical and Geographical (8½ pp.); III., Zoological (44 pp.); and Bibliography (11 pp.). The 36 double-page plates following are mostly divided to include six world maps each, thus making about 200 maps in all. "All the families of mammals, birds, reptiles and amphibians, together with several of the more important genera and species, have been dealt with, while the work embraces in addition most of the families of fishes and a selection of families and genera of molluscs and insects." Two plates show the zoogeographical regions according to various authors, while another indicates diagrammatically the vertical and latitudinal distribution of life and inset maps illustrate prevailing vegetation, ocean currents and bathy-orographical configuration.

As a contribution to the subject of zoogeography, the work makes no serious pretensions, being strictly a compilation from existing published data, and as such is to be judged like a geography or a dictionary. In scope and finish, it surpasses anything previously attempted and will doubtless fill in large measure the place which has long been waiting for such a work, both in special and in general libraries. The great advances in knowledge of the distribution of life made in recent decades render a graphic accounting of this sort particularly welcome. The difficulties of fully attaining the desired object, however, are very great. Many groups, even of the higher vertebrates, have not been thoroughly studied from the distributional standpoint and only in few instances are the data to be found collated for use. Instead they are widely scattered, often extending into the literature of several tongues and variously concealed among irrelevant matter. On this account, perhaps one should not assume too critical an attitude toward the detailed results of a necessarily involved task subject to the limitations of time and generalized authorship. To be beyond particular criticism, such a comprehensive work could be produced only by the combined effort of a number of specialists.

One may readily understand and excuse omissions in a work of this nature, but gratuitous extensions of distribution can not be passed so lightly, for misgivings arise as to the methods pursued. The authority, for example, which led to the extension of the range of the jaguar over the whole peninsula of Lower California must have been one which stated things in very general terms. The same may be said of carrying the distinctive color for the raccoon up the coast of British Columbia and Alaska to the base of the Alaska peninsula—a matter of over 1,000 miles of distribution without basis in fact. That this is not a mere slip is indicated by a statement of the same error in the text. The sewellels (*Aplodontia*) are given a range from Puget Sound to San Diego and the pocket gophers (Geomyidæ) cover Vancouver Island and the coast of British Columbia north to the southern boundary of Alaska, considerable deviations from the real conditions. Although the reviewer has given more hasty and less competent scrutiny to the maps of groups other than the Mammalia, there are indications that no greater degree of accuracy obtains among them. One instance may be cited in the Insecta in the ranges of the well-known genera of mosquitoes, *Anopheles* and *Stegomyia*. The former is carried north to Hudson Bay and the latter to central Wisconsin, both somewhat beyond the limits known. In view of these shortcomings and others which might be mentioned, it is evident the maps can not be trusted for finer points of distribution; but they are so well executed and so useful in their general bearings that one almost feels tempted to withhold detailed criticism.

The text is brief but somewhat more than a mere explanation of the maps. In discussing the general subject, it is interesting to note that although they adopt the classic divisions of Wallace and accord first and most promi-

nent place to his map, the authors have not been able to avoid various parenthetical and semi-apologetic references to the "holarctic." The divisions of Sclater, made in 1857, are introduced as the beginnings of zoogeography and no mention is made of the much earlier work of Wagner in 1844[1] nor of the map published by Agassiz in 1854.[2] The groups illustrated by the maps are taken up in systematic order in the zoological text, the number of species in each is stated, peculiarities of distribution are mentioned, and brief statements are given of the character and habits of the animals. In addition, the number of fossil forms in each is stated. The distribution of fossil forms is not illustrated and only the present range is shown of animals that have become restricted during historic times. The bibliography is conveniently classified according to regions and groups and is rather extensive, although necessarily consisting of selected titles, since the number of publications having some pertinence is almost unlimited. Certain important papers are omitted, however, and many rather inconsequential ones have a place. Under Neotropical Region, one notes with some surprise the absence of any reference to such important works as Azara's "Paraguay," Tschudi's "Fauna Peruana," Maximilian's "Naturgeschichte," Castelnau's "Expedition," and Darwin and Waterhouse's "Zoology of the Voyage of the Beagle."

As a book, the atlas is very pleasing. The binding, paper, typography and arrangement are excellent. All the maps are mounted on linen-hinged tabs and the colors employed in limiting the distribution areas are soft and harmonious. That it will have a large sphere of usefulness is unquestionable and in spite of what must be said as to looseness of detail, a large measure of gratitude is due the authors for having performed the prodigious labor involved and produced a work on such excellent general lines.

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[1] "Die Geographische Verbreitung der Saugethiere."

[2] In Nott and Gliddon's "Types of Mankind."

Der Aufbau der Skeletteile in den freien Gliedmassen der Wirbeltiere. Untersuchungen an urodelen Amphibien. By H. VON EGGELING, a. o. Professor und Prosektor anatom. Anstalt Universität Jena. Gustav Fischer. 1911. Pp. 324, with 4 lithographic plates; 147 figures in the text.

The author states in the preface that he was led to undertake a broad study of the comparative anatomy and histogenesis of the skeleton and ligaments because of the unsatisfactory literature on this subject which he was able to find when beginning a course of lectures at Jena. The present volume represents the first stage of this study and contains an extensive account of the skeletal structure of the limbs of urodeles. The three questions of general bearing which the author set for himself on taking up the study were as follows:

1. "In what relation to one another stand the so-called coarse-fibrous and fine-fibrous bony substances, the 'Wurzelstock' of Gegenbaur, the cement of the teeth and Sharpey's fibers? What part do these structures take in the structure of bone, aside from a merely topographical one?"

2. "What is the phylogenetic development of the compact bony substance of long bones? How have the Haversian canals arisen, to what extent does their ontogenetic development reproduce their phylogenesis? Are biological conditions to be made out on which the development of vascular canals appears dependable?"

3. "What appears to be the phylogenetic development of enchondral ossification? In what form and under what conditions arise the marrow cavity and the bone-marrow? Where, in what form, and under what conditions do the centers of ossification of the epiphyses develop? Is there an explanation for the late, purely enchondral, ossification of the carpus and tarsus of mammals?"

The author gives a good review of the literature dealing with the questions which he postulates, then gives an account of the structure of the limb skeleton in the amphibians which he himself has studied, some twenty-

five different species belonging to the phanerobranchiata, the cryptobranchiata, the lechriodonta and the mecodonta. He comes to the following conclusions in answer to the three questions postulated:

1. Osseous tissue is divisible into two distinct classes, coarse-fibrous and fine-fibrous. Coarse-fibrous bone is the more primitive of the two. It is formed beneath the periosteum from which at first it is not sharply separated, and in ontogenetically and phylogenetically primitive conditions the coarse fiber-bundles are usually interwoven in an irregular manner. In highly developed bone the fiber-bundles are more regularly arranged. Some fine-fibrous bone is usually interspersed among the coarse fiber-bundles. Sharpey's fibers are those bundles of coarse-fibrous bony substance which extend inwards perpendicular to the periosteum. The cement substance of the teeth and the substance of the basal plates in placoid organs of selachians are to be classed with coarse-fibrous bone. Fine-fibrous bone is laid down about the loose connective tissue which accompanies the blood vessels which are enclosed in the sub-periosteal bone or which penetrate the endochondrium. It is laid down in concentric layers about the spaces in which the blood vessels lie. No coarse fiber-bundles are ever interspersed among these concentric layers. The dentine of placoid organs and of the teeth is of a nature similar to fine-fibrous bone.

2. Compact bone is composed mainly of fine-fibrous bone and is a far higher type of bone than the primitive coarse-fibrous bone. The vascular canals in bone appeared at first as the chance accompaniment of the periosteal development of bone. They proved useful for the nutrition of the bone. Their importance became increased when fine-fibrous bone was laid down in concentric layers about their walls and when blood-corpuscle-forming bone-marrow was developed from the loose connective tissue accompanying the blood vessels.

3. Enchondral ossification represents the spread of the vascular canals from periosteal bone into axial cartilage. Marrow cavities arose through the anastomosis of branched vascular canals and were present even in the extinct ancestors of the present amphibians. The marrow cavity first appeared in the shaft, then extended into the epiphyses. The development in the epiphyses of special marrow cavities by the ingrowth of blood vessels from the surrounding periosteum represents a relatively advanced stage of development. The elements of the carpus and tarsus phylogenetically long remain cartilaginous. In some of the lower forms there is a slight periosteal ossification of these bones, but this is never extensive and is not found at all in the highest vertebrates in which the ossification of these bones is purely enchondral.

From this study of the development of the skeleton of the limbs in urodeles the author is inclined to take the view that the phanerobranchiates, the cryptobranchiates and siredon are derived from the caducibranchiates. The caducibranchiates, he thinks, are divisible into two groups, of which one, including the desmognathinæ and the plethodontinæ are distinguished from the second group, the salamandrinæ and amblystoma opacum, by a lesser development of marrow cavities, the simple structure of the carpal and tarsal bones, and the almost complete absence of fat cells in the bone marrow.

The monograph, as a whole, represents a careful and satisfactory study of the subject.

C. R. BARDEEN

SCIENTIFIC JOURNALS AND ARTICLES

THE twenty-second volume of the *Journal of Morphology* is a memorial volume in honor of Charles Otis Whitman. The third part, issued on September 20, contains the following articles:

"Some Problems of Cœlenterate Ontogeny," Charles W. Hargitt.

"Physiological Animal Geography," Victor E. Shelford.

"On the Olfactory Organs and the Sense of Smell in Birds," R. M. Strong.

"On the Regular Seasonal Changes in the Relative Weight of the Central Nervous System of the Leopard Frog," Henry H. Donaldson.

"The Physiology of Cell-division. IV., The Action of Salt Solutions followed by Hypertonic Sea-water on Unfertilized Sea-urchin Eggs and the Rôle of Membranes in Mitosis," Ralph S. Lillie.

"The Spermatogenesis of an Hemipteron, Euschistus," Thos. H. Montgomery, Jr.

"The Life History of the *Scolex polymorphus* of the Woods Hole Region," Winterton C. Curtis.

SPECIAL ARTICLES

ON SOME CONDITIONS OF TISSUE GROWTH, ESPECIALLY IN CULTURE MEDIA

In a paper on the regeneration of epithelium published almost fourteen years ago[1] I analyzed some of the internal and external factors in the growth of mammalian tissues and demonstrated the existence of stereotropism in regenerating epithelial cells. I also cited certain statements of other observers which suggested to me the existence of a stereotropic sensitiveness in other varieties of growing vertebrate tissues.

At that time I furthermore had the opportunity to observe that epithelium might grow and show its stereotropic reaction without relation to the underlying tissue, growing merely in contact with blood coagula. This observation suggested to me the possibility of cultivating tissues of vertebrates in culture media *in vivo* as well as *in vitro*, in a similar manner as bacteria had been cultivated. My previous observations on the importance of the contact with solid substances in tissue growth induced me to use solid coagula as the culture medium.[2] I published a communication concerning these first experiments (which had been carried out in Baltimore).[3] In further experiments accidental conditions made it necessary to study the growth of mammalian tissues in culture media with the animal body acting as an incubator. The results of these experiments have been published in detail.[4] To our knowledge in these earlier experiments, for the first time the attempt was recorded in the literature to grow tissues of higher animals under artificial conditions, to separate through culture media experimentally growing epithelial from connective tissue cells and furthermore to study the influence of the addition of certain chemicals upon the growth of tissues.[5]

Demands of other investigations prevented me from extending these experiments into various directions, as I had planned to do for a considerable number of years. Only recently I resumed these studies and I analyzed further the growth of tissues in solid coagula, especially differentiating between the reactions of stroma and parenchyma in tissue growth in culture media. Here I will add the results of some further studies which were made in conjunction with my collaborator, Dr. Moyer S. Fleisher, and a more detailed account of which will appear elsewhere.

1. We investigated to what extent oxygen is necessary for the growth of mammalian tissues in culture media, a problem which had interested me from the beginning of my experiments. In the case of certain higher plants it has been recently shown that a limited anaerobic growth is possible. We used various methods of anaerobic culture methods and we also studied the effect of a diminution in the supply of oxygen. Our results show that growth ceases if oxygen is lacking or noticeably diminished. This applies to various tissues. A noteworthy difference in the reaction of various tissues to lack of oxygen we could not observe. Under these conditions tissues not only cease to grow, but they die. It is much more difficult to determine the effect of an increase in the tension of oxygen on tissue growth. Our experiments, however, make it very probable that in certain cases the life and growth of tissues is favorably influenced if pure oxygen takes the place of air surrounding the culture media.

2. We studied the effect of the combined growth of an oidium-like organism[6] and of

[1] "Ueber Regeneration des Epithels" (chapter 13), *Archiv f. Entw'mech.*, Bd. VI., 1898.

[2] I referred to this circumstance again in a communication to the Society of Experimental Biology and Medicine, Proceedings of the 44th meeting, May 17, 1911.

[3] Chicago, 1907.

[4] *Archiv f. Entw'mech.*, Bd. XIII., 1902; *Journ. Med. Research*, Vol. VIII., 1902; *Journ. Am. Med. Association*, 1901.

[5] *Zeitschrift f. Krebsforschung*, Bd. V., 1907.

[6] This organism was studied in conjunction with Dr. George J. Moore, of St. Louis, and will be described elsewhere.

kidney tissue. This organism had been injected into the circulation of a rabbit and at various periods after the injection pieces of the kidney were transferred into the culture media. In these experiments we found not only that both kidney tissue, stroma and parenchyma, and organism may grow side by side in the culture media, but that under certain conditions the growth of the kidney cells may be quantitatively increased.

It will be of interest to extend these studies to other well-defined microorganisms and to test the effect of their metabolic products and direct action on tissue growth.

3. The stereotropic sensitiveness of connective tissue cells can very well be observed in the process of atresia of the ovarian follicle. At a period when the degeneration of the granulosa has set in, connective tissue cells begin to grow from the surrounding theca into the follicular cavity and to fill it more or less completely. Here we can notice that usually the connective tissue cells do not grow directly into the cavity but move in contact with the wall of the follicle, thus forming a peripheral layer of connective tissue which gradually enlarges as more cells are added.

In certain cases, however, we may observe that connective tissue cells grow directly into the cavity. In these cases it is probable that the viscosity of the follicular fluid is relatively great and that a viscous fluid may permit a direct ingrowth of some tissue cells.

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ON AN INTERPOLATION FORMULA USED IN CALCULATING TEMPERATURE COEFFICIENTS FOR VELOCITY OF VITAL ACTIVITIES, TOGETHER WITH A NOTE ON THE VELOCITY OF NERVE CONDUCTION IN MAN

INQUIRIES, both written and verbal, have come to me asking for information concerning a formula which has been employed in some of my physiological papers on temperature coefficients.

In this communication I wish to answer these inquiries (1) by referring to the antecedents and mathematical significance of the formula as briefly as I may, and (2) by giving one or two examples of its application.

In the first place it must be stated that the formula in question, so far as my work is concerned, is entirely an empirical one. Wherever a series of quantities varies with some exponential factor the formula has been found to be fairly satisfactory for extra- and interpolation. Its origin, as far as I (who am not a mathematician) know, is probably "lost in antiquity." Professor Max Bodenstein, of Hanover, has told me, however, that he thought Berthelot first used it in chemistry. Just lately I find that Bodenstein[1] himself made use of the formula in 1899 for the determination of the temperature coefficient of chemical reaction velocities.

On the other hand, the formula of van't Hoff[2] and Arrhenius,[3] among others, were developed from thermodynamic considerations and therefore have important theoretical foundations.

However, the formula I use,

$$\left(\frac{k_1}{k_0}\right)^{\frac{10}{t_1-t_0}}=Q_{10} \tag{1}$$

is practically the same, I find, as one of van't Hoff's,[4] namely,

$$\log_{10} k=a+bt. \tag{2}$$

For if the values of k in (2) for two different temperatures are known, then this equation may be derived:

$$\frac{k_{t+10}}{k_t}=10^{10\cdot b}. \tag{3}$$

Equation (1) is probably more convenient for the calculation of quotients for intervals of 10 degrees (temperature coefficients), but it is also more cumbersome for the calculation

[1] Bodenstein, M., *Zeitschrift für physikalische Chemie*, 1899, Bd. 29, S. 332.

[2] Van 't Hoff, "Etudes de dynamique chimique," 1884, p. 115.

[3] Arrhenius, *Zeitschrift für physikalische Chemie*, 1899, Bd. 4, S. 226; "Immunochemie," Leipzig, 1907.

[4] Van 't Hoff, *Vorlesungen über theoretische und physikalische Chemie*, 1898, I., S. 224.

of the value of k. This appears from the following:

From equation (1) we have

$$\log_{10} k_1 = \log_{10} k_0 + \left(\frac{t_1 - t_0}{10} \cdot \log_{10} Q_{10}\right),$$

whence

$$k_1 = 10^{\log_{10} k_0 + \left(\frac{t_1 - t_0}{10} \cdot \log_{10} Q_{10}\right)}. \tag{4}$$

Of course in order to use the simpler equation (2) one must calculate out the values of the constants and these vary, it must be remembered, with the nature of reaction involved.

And now for an example or two to illustrate the application of these formulæ. Barcroft and King[5] studied the effect of temperature upon the dissociation of hemoglobin. In one series of observations an aqueous solution of pure crystals under 10 mm. Hg pressure showed at 14° C. 92 per cent. saturation; at 38°, 24 per cent. saturation. What is the temperature coefficient for intervals of 10 degrees?

This is answered by using either equations (1) or (3). Substituting the observed values in equation (1) we have

$$\left(\frac{92}{24}\right)^{\frac{10}{38-14}} = Q_{10},$$

whence $Q_{10} = 1.75$, the temperature coefficient for intervals of 10 degrees.

From equation (2) or (4) we can now calculate the values of k for the whole of this series of Barcroft and King's observations.

By comparing equations (1) and (3) it will be seen that $Q_{10} = 10^{10 \cdot b}$. Since $Q_{10} = 1.75$, $b = .0243$ and therefore a in equation (2) equals $-.3579$. For the special case under consideration, then, equation (2) reads

$$\log_{10} k = -.3579 + .0243\, t.$$

The table of observed and calculated values of k stands as follows:

Temp. Degrees	k Observed, Per Cent.	k Calculated, Per Cent.
14	92	96
26	56	54
32	38	38
38	24	27

[5] Barcroft and King, *Journal of Physiology*, 1909, Vol. 39, p. 374.

Another and very different example may be taken from the physiology of nerve. As is well known, frog nerve at a temperature of 20° C. conducts the impulse at a rate of about 30 meters per second. It has, furthermore, been shown that the temperature coefficient, or the value of Q_{10} in the above equations, for the conduction time of frog nerve,[6] is about 2.3.

Now if the nature of nerve in both frog and man be essentially the same, the value of Q_{10} is also the same, and from equation (4), which is another expression of (1), we may proceed to calculate the velocity of the nervous impulse in man.

The known values are substituted in (4), taking 37° as the body temperature of man, whence

$$k_1 = 10^{\log_{10} k_0 + \left(\frac{37-20}{10} \cdot \log_{10} 2.3\right)}$$

or $k_1 = 123.6$.

The same result is obtained from equation (2). For since $Q_{10} = 10^{10 \cdot b}$, then $b = .0362$, and for the special case of frog $a = 0.753$, because

$$\log_{10} 30 = a + .0362 \times 20.$$

For the special case of man, then,

$$\log_{10} k = 0.753 + .0362 \times 37,$$

whence $k = 123.6$.

From the above, therefore, we deduce that the velocity of the nervous impulse in man is about 123.6 meters per second. Can this be corroborated by experiment? Happily it can. Professor Piper,[7] of Berlin, has been able to measure the conduction time of the median nerve in man by using the very sensitive and promptly reacting thread galvanometer. From his results he calculates a rate from 117 to 125 meters per second. Using a similar galvanometer, I have been able to confirm this in our laboratory

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[6] Snyder, C. D., Archiv für Anatomie und Physiologie. Physiologische Abteilung, 1907, S. 117; *American Journal of Physiology*, 1908, Vol. 22, p. 309.

[7] Piper, H., *Archiv für die gesammte Physiologie*, 1908, 124, p. 591.

SCIENCE

FRIDAY, OCTOBER 6, 1911

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

MAGNALIA NATURÆ; OR, THE GREATER PROBLEMS OF BIOLOGY[1]

THE science of zoology, all the more the incorporate science of biology, is no simple affair, and from its earliest beginnings it has been a great and complex and many-sided thing. We can scarce get a broader view of it than from Aristotle, for no man has ever looked upon our science with a more far-seeing and comprehending eye. Aristotle was all things that we mean by "naturalist" or "biologist." He was a student of the ways and doings of beast and bird and creeping thing; he was morphologist and embryologist; he had the keenest insight into physiological problems, though lacking that knowledge of the physical sciences without which physiology can go but a little way: he was the first and is the greatest of psychologists; and in the light of his genius biology merged in a great philosophy.

I do not for a moment suppose that the vast multitude of facts which Aristotle records were all, or even mostly, the fruit of his own immediate and independent observation. Before him were the Hippocratic and other schools of physicians and anatomists. Before him there were nameless and forgotten Fabres, Röesels, Réaumurs and Hubers, who observed the habits, the diet and the habitations of the sand-wasp or the mason-bee; who traced out the little lives, and discerned the vocal organs, of grasshopper and cicada; and who, together with generations of bee-keeping

[1] Address of the president to the Zoological Section. Portsmouth, 1911.

peasants, gathered up the lore and wisdom of the bee. There were fishermen skilled in all the cunning of their craft, who discussed the wanderings of tunny and mackerel, sword-fish or anchovy; who argued over the ages, the breeding-places and the food of this fish or that; who knew how the smooth dogfish breeds two thousand years before Johannes Müller; who saw how the male pipe-fish carries its young before Cavolini; and who had found the nest of the nest-building rock-fishes before Gerbe rediscovered it almost in our own day. There were curious students of the cuttle-fish (I sometimes imagine they may have been priests of that sea-born goddess to whom the creatures were sacred) who had diagnosed the species, recorded the habits and dissected the anatomy of the group, even to the discovery of that strange hectocotylus arm that baffled Della Chiaje, Cuvier and Koelliker, and that Verany and Heinrich Müller reexplained.

All this varied learning Aristotle gathered up and wove into his great web. But every here and there, in words that are unmistakably the master's own, we hear him speak of what are still the great problems and even the hidden mysteries of our science; of such things as the nature of variation, of the struggle for existence, of specific and generic differentiation of form, of the origin of the tissues, the problems of heredity, the mystery of sex, of the phenomena of reproduction and growth, the characteristics of habit, instinct and intelligence, and of the very meaning of life itself. Amid all the maze of concrete facts that century after century keeps adding to our store, these, and such as these, remain the great mysteries of natural science—the *Magnalia naturæ*, to borrow a great word from Bacon, who in his turn had borrowed it from St. Paul.

Not that these are the only great problems for the biologist, nor that there is even but a single class of great problems in biology. For Bacon himself speaks of the *magnalia naturæ, quoad usus humanos,* the study of which has for its objects "the prolongation of life or the retardation of age, the curing of diseases counted incurable, the mitigation of pain, the making of new species and transplanting of one species into another," and so on through many more. Assuredly I have no need to remind you that a great feature of this generation of ours has been the way in which biology has been justified of her children, in the work of those who have studied the *magnalia naturæ, quoad usus humanos.*

But so far are biologists from being nowadays engrossed in practical questions, in applied and technical zoology, to the neglect of its more recondite problems, that there never was a time when men thought more deeply or labored with greater zeal over the fundamental phenomena of living things; never a time when they reflected in a broader spirit over such questions as purposive adaptation, the harmonious working of the fabric of the body in relation to environment and the interplay of all the creatures that people the earth; over the problems of heredity and variation; over the mysteries of sex and the phenomena of generation and reproduction, by which phenomena, as the wise woman told, or reminded, Socrates, and as Harvey said again (and for that matter, as Coleridge said, and Weismann, but not quite so well) —by which, as the wise old woman said, we gain our glimpse of insight into eternity and immortality. These then, together with the problem of the origin of species, are indeed *magnalia naturæ;* and I take it that inquiry into these, deep and wide research specially directed to the solution of these, is characteristic of the spirit of our

time, and is the pass-word of the younger generation of biologists.

Interwoven with this high aim which is manifested in the biological work of recent years is another tendency. It is the desire to bring to bear upon our science, in greater measure than before, the methods and results of the other sciences, both those that in the hierarchy of knowledge are set above and below, and those that rank alongside of our own.

Before the great problems of which I have spoken, the cleft between zoology and botany fades away, for the same problems are common to the two sciences. When the zoologist becomes a student not of the dead but of the living, of the vital processes of the cell rather than of the dry bones of the body, he becomes once more a physiologist, and the gulf between these two disciplines disappears. When he becomes a physiologist, he becomes, *ipso facto,* a student of chemistry and of physics. Even mathematics has been pressed into the service of the biologist, and the calculus of probabilities is not the only branch of mathematics to which he may usefully appeal.

The physiologist has long had as his distinguishing characteristic, giving his craft a rank superior to the sister branch of morphology, the fact that in his great field of work, and in all the routine of his experimental research, the methods of the physicist and the chemist, the lessons of the anatomist, and the experience of the physician are inextricably blended in one common central field of investigation and thought. But it is much more recently that the morphologist and embryologist have made use of the method of experiment, and of the aid of the physical and chemical sciences—even of the teachings of philosophy: all in order to probe into properties of the living organism that men were wont to take for granted, or to regard as beyond their reach, under a narrower interpretation of the business of the biologist. Driesch and Loeb and Roux are three among many men who have become eminent in this way in recent years, and their work we may take as typical of methods and aims such as those of which I speak. Driesch, both by careful experiment and by philosophic insight, Loeb, by his conception of the dynamics of the cell and by his marvellous demonstrations of chemical and mechanical fertilization, Roux, with his theory of auto-determination, and by all the labors of the school of *Entwickelungsmechanik* which he has founded, have all in various ways, and from more or less different points of view, helped to reconstruct and readjust our ideas of the relations of embryological processes, and hence of the phenomenon of life itself, on the one hand to physical causes (whether external to or latent in the mechanism of the cell), or on the other to the ancient conception of a vital element alien to the province of the physicist.

No small number of theories or hypotheses, that seemed for a time to have been established on ground as firm as that on which we tread, have been reopened in our day. The adequacy of natural selection to explain the whole of organic evolution has been assailed on many sides; the old fundamental subject of embryological debate between the evolutionists or preformationists (of the school of Malpighi, Haller and Bonnet) and the advocates of epigenesis (the followers of Aristotle, of Harvey, of Caspar F. Wolff and of Von Baer) is now discussed again, in altered language, but as a pressing question of the hour; the very foundations of the cell-theory have been scrutinized to decide, for instance, whether the segmented ovum, or even the complete organism, be a colony of quasi-independent cells, or a living unit in which cell differ-

entiation is little more than a superficial phenomenon; the whole meaning, bearing and philosophy of evolution has been discussed by Bergson, on a plane to which neither Darwin nor Spencer ever attained; and the hypothesis of a vital principle, or vital element, that had lain in the background for near a hundred years, has come into men's mouths as a very real and urgent question, the greatest question for the biologist of all.

In all ages the mystery of organic form, the mystery of growth and reproduction, the mystery of thought and consciousness, the whole mystery of the complex phenomena of life, have seemed to the vast majority of men to call for description and explanation in terms alien to the language which we apply to inanimate things; though at all times there have been a few who sought, with the materialism of Democritus, Lucretius or Giordano Bruno, to attribute most, or even all, of these phenomena to the category of physical causation.

For the first scientific exposition of vitalism, we must go back to Aristotle, and to his doctrine of the three parts of the tripartite soul: according to which doctrine, in Milton's language, created things "by grandual change sublimed, To vital spirits aspire, to animal, To intellectual!" The first and lowest of these three, the ψυχὴ ἡ θρεπτική, by whose agency nutrition is effected, is ἡ πρώτη ψυχή, the inseparable concomitant of life itself. It is inherent in the plant as well as in the animal and in the Linnean aphorism, *Vegetabilia crescunt et vivunt,* its existence is admitted in a word. Under other aspects, it is all but identical with the ψυχὴ αὐξητική and γεννητική the soul of growth and of reproduction: and in this composite sense it is no other than Driesch's "Entelechy," the hypothetic natural agency that presides over the form and formation of the body. Just as Driesch's psychoid or psychoids, which are the basis of instinctive phenomena, of sensation, instinct, thought, reason, and all that directs that body which entelechy has formed, are no other than the αἰσθητική, whereby *animalia vivunt et sentiunt,* and the διανοητική to which Aristotle ascribes the reasoning faculty of man. Save only that Driesch like Darwin, would deny the restriction of νοῦς, or reasoning, to man alone, and would extend it to animals, it is clear, and Driesch himself admits,[2] that he accepts both the vitalism and the analysis of vitalism laid down by Aristotle.

The πνεῦμα of Galen, the *vis plastica,* the *vis vitæ formatrix,* of the older physiologist, the *Bildungstrieb* of Blumenbach, the *Lebenskraft* of Paracelsus, Stahl and Treviranus, "shaping the physical forces of the body to its own ends," "dreaming dimly in the grain of the promise of the full corn in the ear,"[3] these and many more, like Driesch's "entelechy" of to-day, are all conceptions under which successive generations strive to depict the something that separates the earthy from the living, the living from the dead. And John Hunter described his conception of it in words not very differentt from Driesch's, when he said that his principle, or agent, was independent of organization, which yet it animates, sustains and repairs; it was the same as Johannes Müller's conception of an innate "unconscious idea."

Even in the middle ages, long before

[2] "Science and Philosophy of the Organism" (Gifford Lectures), II., p. 83, 1908.

[3] *Cit.* Jenkinson (Art. "Vitalism," in *Hibbert Journal,* April, 1911), who has given me the following quotation: "Das Weizenkorn hat allerdings Bewusstsein dessen was in ihm ist und aus ihm werden kann, und traümt wirklich davon. Sein Bewusstsein und seine Träume mögen dunkel genung sein"; Treviranus, "Erscheinungen und Gesetze des organischen Lebens," 1831.

Descartes, we can trace, if we interpret the language and the spirt of the time, an antithesis that, if not identical, is at least parallel to our alternative between vitalistic and mechanical hypotheses. For instance, Father Harper tells us that Suarez maintained, in opposition to St. Thomas, that in generation and development a divine interference is postulated, by reason of the perfection of living beings; in opposition to St. Thomas, who (while invariably making an exception in the case of the human soul) urged that, since the existence of bodily and natural forms consists solely in their union with matter, the ordinary agencies which operate on matter sufficiently account for them.[4]

But in the history of modern science, or of modern physiology, it is of course to Descartes that we trace the origin of our mechanical hypotheses—to Descartes, who, imitating Archimedes, said, "Give me matter and motion, and I will construct the universe." In fact, leaving the more shadowy past alone, we may say that it is since Descartes watched the fountains in the garden, and saw the likeness between their machinery of pumps and pipes and reservoirs to the organs of the circulation of the blood, and since Vaucanson's marvelous automata lent plausibility to the idea of a "living automaton," it is since then that men's minds have been perpetually swayed by one or other of the two conflicting tendencies, either to seek an explanation of the phenomena of living things in physical and mechanical considerations, or to attribute them to unknown and mysterious causes, alien to physics and peculiarly concomitant with life. And some men's temperaments, training, and even avocations, render them more prone to the one side of this unending controvery, as the minds of other men are naturally more open to the other. As Kühne said a few years ago at Cambridge, the physiologists have been found for several generations leaning on the whole to the mechanical or physico-chemical hypothesis, while the zoologists have been very generally on the side of the vitalists.

The very fact that the physiologists were trained in the school of physics, and the fact that the zoologists and botanists relied for so many years upon the vague undefined force of "heredity" as sufficiently accounting for the development of the organism, an intrinsic force whose results could be studied but whose nature seemed remote from possible analysis or explanation, these facts alone go far to illustrate and to justify what Kühne said.

Claude Bernard held that mechanical, physical and chemical forces summed up all with which the physiologist has to deal. Verworn defined physiology as "the chemistry of the proteids"; and I think that another physiologist (but I forget who) has declared that the mystery of life lay hidden in "the chemistry of the enzymes." But of late, as Dr. Haldane showed in his address a couple of years ago to the Physiological Section, it is among the physiologists themselves, together with the embryologists, that we find the strongest indications of a desire to pass beyond the horizon of Descartes, and to avow that physical and chemical methods, the methods of Helmholtz, Ludwig and Claude Bernard, fall short of solving the secrets of physiology. On the other hand, in zoology, resort to the

[4] "Cum formarum naturalium et corporalium esse non consistat nisi in unione ad materiam; ejusdem agentis esse videtur eas producere, cujus est materiam transmutare. Secundo, quia cum hujusmodi formæ non excedant virtutem et ordinem et facultatem principiorum agentium in natura, nulla videtur necessitas eorum originem in principia reducere altiora."—Aquinas, "De Pot.," Q. III., *a*, 11; Cf. Harper, "Metaphysics of the School," III., 1, p. 152.

method of experiment, the discovery, for instance, of the wonderful effects of chemical or even mechanical stimulation in starting the development of the egg, and again the ceaseless search into the minute structure, or so-called mechanism, of the cell, these, I think, have rather tended to sway a certain number of zoologists in the direction of the mechanical hypothesis.

But on the whole, I think it is very manifest that there is abroad on all sides a greater spirit of hesitation and caution than of old, and that the lessons of the philosopher have had their influence on our minds. We realize that the problem of development is far harder than we had begun to let ourselves suppose: that the problems of organogeny and phylogeny (as well as those of physiology) are not comparatively simple and well-nigh solved, but are of the most formidable complexity. And we would, most of us, confess, with the learned author of "The Cell in Development and Inheritance," "that we are utterly ignorant of the manner in which the substance of the germ-cell can so respond to the influence of the environment as to call forth an adaptive variation; and again, that the gulf between the lowest forms of life and the inorganic world is as wide as, if not wider than, it seemed a couple of generations ago."[5]

While we keep an open mind on this question of vitalism, or while we lean as so many of us now do, or or even cling with a great yearning, to the belief that something other than the physical forces animates and sustains the dust of which we are made, it is rather the business of the philosopher than of the biologist, or of the biologist only when he has served his humble and severe apprenticeship to philosophy, to deal with the ultimate problem. It is the plain bounden duty of the biologist to pursue his course, unprejudiced by vitalistic hypotheses, along the road of observation and experiment, according to the accepted discipline of the natural and physical sciences; indeed, I might perhaps better say the physical sciences alone, for it is already a breach of their discipline to invoke, until we feel we absolutely must, that shadowy force of "heredity," to which, as I have already said, biologists have been accustomed to ascribe so much. In other words, it is an elementary scientific duty, it is a rule that Kant himself laid down,[6] that we should explain, just as far as we possibly can, all that is capable of such explanation, in the light of the properties of matter and of the forms of energy with which we are already acquainted.

It is of the essence of physiological science to investigate the manifestations of energy in the body, and to refer them, for instance, to the domains of heat, electricity or chemical activity. By this means a vast number of phenomena, of chemical and other actions of the body, have been relegated to the domain of physical science and withdrawn from the mystery that still attends on life: and by this means, continued for generations, the physiologists, or certain of them, now tell us that we begin again to descry the limitations of physical inquiry, and the region where a very different hypothesis insists on thrusting itself in. But the morphologist has not gone nearly so far as the physiologist in the use of physical methods. He sees so great a gulf between the crystal and the cell, that the very fact of the physicist and the mathematician being able to explain the form of the one, by simple laws of spatial arrangement where molecule fits into molecule, seems to deter, rather than to attract, the biologist from attempting to explain organic forms by mathematical or physical

[5] Wilson, *op. cit.*, 1906, p. 434.

[6] In his "Critique of Teleological Judgment."

law. Just as the embryologist used to explain everything by heredity, so the morphologist is still inclined to say, "the thing is alive, its form is an attribute of itself, and the physical forces do not apply." If he does not go so far as this, he is still apt to take it for granted that the physical forces can only to a small and even insignificant extent blend with the intrinsic organic forces in producing the resultant form. Herein lies our question in a nutshell. Has the morphologist yet sufficiently studied the forms, external and internal, of organisms, in the light of the properties of matter, of the energies that are associated with it, and of the forces by which the actions of these energies may be interpreted and described? Has the biologist, in short, fully recognized that there is a borderland not only between physiology and physics, but between morphology and physics, and that the physicist may, and must, be his guide and teacher in many matters regarding organic form?

Now this is by no means a new subject, for such men as Berthold and Errera, Rhumbler and Dreyer, Bütschli and Verworn, Driesch and Roux, have already dealt or deal with it. But on the whole it seems to me that the subject has attracted too little attention, and that it is well worth our while to think of it to-day.

The first point, then, that I wish to make in this connection is, that the form of any portion of matter, whether it be living or dead, its form and the changes of form that are apparent in its movements and in its growth, may in all cases alike be described as due to the action of force. In short, the form of an object is a "diagram of forces" —in this sense at least, that from it we can judge of or deduce the forces that are acting or have acted upon it; in this strict and particular sense, it is a diagram: in the case of a solid, of the forces that *have* been impressed upon it when its conformation was produced, together with those that enable it to retain its conformation; in the case of a liquid (or of a gas), of the forces that are for the moment acting on it to restrain or balance its own inherent mobility. In an organism, great or small, it is not merely the nature of the *motions* of the living substance that we must interpret in terms of force (according to kinetics), but also the *conformation* of the organism itself, whose permanence or equilibrium is explained by the interaction or balance of forces, as described in statics.

If we look at the living cell of an *Amœba* or a *Spirogyra*, we see a something which exhibits certain active movements, and a certain fluctuating, or more or less lasting, form; and its form at a given moment, just like its motions, is to be investigated by the help of physical methods, and explained by the invocation of the mathematical conception of force.

Now the state, including the shape or form, of a portion of matter is the resultant of a number of forces, which represent or symbolize the manifestations of various kinds of energy; and it is obvious, accordingly, that a great part of physical science must be understood or taken for granted as the necessary preliminary to the discussion on which we are engaged.

I am not going to attempt to deal with, or even to enumerate, all the physical forces or the properties of matter with which the pursuit of this subject would oblige us to deal—with gravity, pressure, cohesion, friction, viscosity, elasticity, diffusion and all the rest of the physical factors that have a bearing on our problem. I propose only to take one or two illustrations from the subject of *surface-tension*, which subject has already so largely engaged the attention of the physiologists. Nor will I even attempt to sketch the gen-

eral nature of this phenomenon, but will only state (as I fear for my purpose I must) a few of its physical manifestations or laws. Of these the most esential facts for us are as follows: Surface-tension is manifested only in fluid or semi-fluid bodies, only at the surface of these: though we may have to interpret surface in a liberal sense in cases where the interior of the mass is other than homogeneous. Secondly, a fluid may, according to the nature of the substance with which it is in contact, or (more strictly speaking) according to the distribution of energy in the system to which it belongs, tend either to spread itself out in a film, or, conversely, to contract into a drop, striving in the latter case to reduce its surface to a minimal area. Thirdly, when three substances are in contact (and subject to surface-tension), as when water surrounds a drop of protoplasm in contact with a solid, then at any and every point of contact, certain definite angles of equilibrium are set up and maintained between the three bodies, which angles are proportionate to the magnitudes of the surface-tensions existing between the three. Fourthly, a fluid film can only remain in equilibrium when its curvature is everywhere constant. Fifthly, the only surfaces of revolution which meet this condition are six in number, of which the plane, the sphere, the cylinder and the so-called unduloid and catenoid are the most important. Sixthly, the cylinder can not remain in free equilibrium if prolonged beyond a length equal to its own circumference, but, passing through the unduloid, tends to break up into spheres: though this limitation may be counteracted or relaxed, for instance, by viscosity. Finally, we have the curious fact that, in a complex system of films, such as a homogeneous froth of bubbles, three partition-walls and no more always meet at a crest, at equal angles, as, for instance, in the very simple case of a layer of uniform hexagonal cells; and (in a solid system) the crests, which may be straight or curved, always meet, also at equal angles, four by four, in a common point. From these physical facts, or laws, the morphologist, as well as the physiologist, may draw important consequences.

It was Hofmeister who first showed, more than forty years ago, that when any drop of protoplasm, either over all its surface or at some free end (as at the tip of the pseudopodium of an *Amœba*), is seen to "round itself off," that is not the effect of physiological or vital contractility, but is a simple consequence of surface-tension—of the law of the minimal surface; and in the physiological side, Engelmann, Bütschli and others have gone far in their development of the idea.

It was Plateau, I think, who first showed that the myriad sticky drops or beads upon the weft of a spider's web, their form, their size, their distance apart, and the presence of the tiny intermediate drops between, were in every detail explicable as the result of surface-tension, through the law of minimal surface and through the corollary to it which defines the limits of stability of the cylinder; and, accordingly, that with their production, the will or effort or intelligence of the spider had nothing to do. The beaded form of a long, thin pseudopodium, for instance of a Heliozoan, is an identical phenomenon.

It was Errera who first conceived the idea that not only the naked surface of the cell but the contiguous surfaces of two naked cells, or the delicate incipient cell-membrane or cell-wall between, might be regarded as a weightless film, whose position and form were assumed in obedience to surface-tension. And it was he who first showed that the symmetrical forms of the unicellular and simple multicellular organ-

isms, up to the point where the development of a skeleton complicates the case, were one and all identical with the plane, sphere, cylinder, unduloid and catenoid, or with combinations of these.

It was Berthold and Errera who, almost simultaneously, showed (the former in far the greater detail) that in a plant each new cell-partition follows the law of minimal surface, and tends (according to another law which I have not particularized) to set itself at right angles to the preceding solidified wall: so giving a simple and adequate physical explanation of what Sachs had stated as an empirical morphological rule. And Berthold further showed how, when the cell-partition was curved, its precise curvature as well as its position was in accordance with physical law.

There are a vast number of other things that we can satisfactorily explain on the same principle and by the same laws. The beautiful catenary curve of the edge of the pseudopodium, as it creeps up its axial rod in a Heliozoan or a Radiolarian, the hexagonal mesh of bubbles, or vacuoles, on the surface of the same creatures, the form of the little groove that runs round the waist of a Peridinian, even (as I believe) the existence, form and undulatory movements of the undulatory membrane of a Trypanosome, or of that around the tail of the spermatozoon of a newt—every one of these, I declare, is a case where the resultant form can be well explained by, and can not possibly be understood without, the phenomenon of surface-tension: indeed, in many of the simpler case the facts are so well explained by surface-tension that it is difficult to find place for a conflicting, much less an overriding, force.

I believe, for my own part, that even the beautiful and varied forms of the Foraminifera may be ascribed to the same cause; but here the problem is just a little more complex, by reason of the successive consolidations of the shell. Suppose the first cell or chamber to be formed, assuming its globular shape in obedience to our law, and then to secrete its calcareous envelope. The new growing bud of protoplasm, accumulating outside the shell, will, in strict accordance with the surface-tensions concerned, either fail to "wet" or to adhere to the first-formed shell, and will so detach itself as a unicellular individual (*Orbulina*); or else it will flow over a less or greater part of the original shell, until its free surface meets it at the required angle of equilibrium. Then, according to this angle, the second chamber may happen to be all but detached (*Globigerina*), or, with all intermediate degrees, may very nearly wholly enwrap the first. Take any specific angle of contact, and presume the same conditions to be maintained, and therefore the same angle to be repeated, as each successive chamber follows on the one before; and you will thereby build up regular forms, spiral or alternate, that correspond with marvelous accuracy to the actual forms of the Foraminifera. And this case is all the more interesting because the allied and successive forms so obtained differ only in degree, in the magnitude of a single physical or mathematical factor; in other words, we get not only individual phenomena, but lines of apparent *orthogenesis*, that seem explicable by physical laws, and attributable to the continuity between successive states in the continuous or gradual variation of a physical condition. The resemblance between allied and related forms, as Hartmann demonstrated and Giard admitted years ago, is not always, however often, to be explained by common descent and parentage.[7]

In the segmenting egg we have the sim-

[7] Cf. Giard, "Discours inaugurale," *Bull. Scientif.* (3), 1, 1888.

pler phenomenon of a "laminar system," uncomplicated by the presence of a solid framework; and here, in the earliest stages of segmentation, it is easy to see the correspondence of the planes of division with what the laws of surface-tension demand. For instance, it is not the case (though the elementary books often represent it so) that when the totally segmenting egg has divided into four segments, the four partition walls ever remain in contact at a single point; the arrangement would be unstable, and the position untenable. But the laws of surface-tension are at once seen to be obeyed, when we recognize the little *cross-furrow* that separates the blastomeres, two and two, leaving in each case three only to meet at a point in our diagram, which point is in reality a section of a ridge or crest.

Very few have tried, and one or two (I know) have tried and not succeeded, to trace the action and the effects of surface-tension in the case of a highly complicated, multi-segemented egg. But it is not surprising if the difficulties which such a case presents appear to be formidable. Even the conformation of the interior of a soap-froth, though absolutely conditioned by surface-tension, presents great difficulties, and it was only in the last years of Lord Kelvin's life that he showed all previous workers to have been in error regarding the form of the interior cells.

But what, for us, does all this amount to? It at least suggests the possibility of so far supporting the observed facts of organic form on mathematical principles, as to bring morphology within or very near to Kant's demand that a true natural science should be justified by its relation to mathematics.[8] But if we were to carry these principles further and to succeed in proving them applicable in detail, even to the showing that the manifold segmentation of the egg was but an exquisite froth, would it wholly revolutionize our biological ideas? It would greatly modify some of them, and some of the most cherished ideas of the majority of embryologists; but I think that the way is already paved for some such modification. When Loeb and others have shown us that half, or even a small portion of an egg, or a single one of its many blastomeres, can give rise to an entire embryo, and that in some cases *any* part of the ovum can originate *any* part of the organism, surely our eyes are turned to the *energies* inherent in the matter of the egg (not to speak of a presiding entelechy), and away from its original formal operations of division. Sedgwick has told us for many years that we look too much to the individuality of the individual cell, and that the organism, at least in the embryonic body, is a continuous syncytium. Hofmeister and Sachs have repeatedly told us that in the plant, the growth of the mass, the growth of the organ, is the primary fact; and De Bary has summed up the matter in his aphorism, "Die Pflanze bildet Zellen, nicht die Zelle bildet Pflanzen." And in many other ways, as many of you are well aware, the extreme position of the cell-theory, that the cells are the ultimate individuals and that the organism is but a colony of quasi-independent cells, has of late years been called in question.

There are no problems connected with morphology that appeal so closely to my mind, or to my temperament, as those that are related to mechanical considerations, to mathematical laws, or to physical and chemical processes.

I love to think of the logarithmic spiral

[8] "Ich behaupte aber dass in jeder besonderen Naturlehre nur so viel *eigentliche* Wissenschaft angetroffen werden könne, als darin Mathematik anzutreffen ist."—Kant, in preface to "Metaphys. Anfangsgründe der Naturwissenschaft" (Werke, ed. Hartenstein, Vol. IV., p. 360).

that is engraven over the grave of that great anatomist, John Goodsir (as it was over that of the greatest of the Bernouillis), so graven because it interprets the form of every molluscan shell, of tusk and horn and claw and many another organic form besides. I like to dwell upon those lines of mechanical stress and strain in a bone that give it its strength where strength is required, that Hermann Meyer and J. Wolff described, and on which Roux has bestowed some of his most thoughtful work; or on the "stream-lines" in the bodily form of fish or bird, from which the naval architect and the aviator have learned so much. I admire that old paper of Peter Harting's in which he paved the way for investigation of the origin of spicules, and of all the questions of crystallization or pseudo-crystallization in presence of colloids, on which subject Lehmann has written his recent and beautiful book. I sympathize with the efforts of Henking, Rhumbler, Hartog, Gallardo, Leduc and others to explain on physical lines the phenomena of nuclear division. And, as I have said to-day, I believe that the forces of surface-tension, elasticity and pressure are adequate to account for a great multitude of the simpler phenomena, and the permutations and combinations thereof, that are illustrated in organic form.

I should gladly and easily have spent all my time this morning in dealing with these questions alone. But I was loath to do so, lest I should seem to overrate their importance, and to appear to you as an advocate of a purely mechanical biology.

I believe all these phenomena to have been unduly neglected, and to call for more attention than they have received. But I know well that though we push such explanations to the uttermost, and learn much in the so doing, they will not touch the heart of the great problems that lie deeper than the physical plane. Over the ultimate problems and causes of vitality, over what is implied in the organization of the living organism, we shall be left wondering still.

To a man of letters and the world like Addison, it came as a sort of revelation that light and color were not objective things but subjective, and that back of them lay only motion or vibration, some simple activity. And when he wrote his essay on these startling discoveries, he found for it, from Ovid, a motto well worth bearing in mind, *causa latet, vis est notissima.* We may with advantage recollect it, when we seek and find the force that produces a direct effect, but stand in utter perplexity before the manifold and transcendent meanings of that great word "cause."

The similarity between organic forms and those that physical agencies are competent to produce still leads some men, such as Stéphane Leduc, to doubt or to deny that there is any gulf between, and to hold that spontaneous generation or the artificial creation of the living is but a footstep away. Others, like Delage and many more, see in the contents of the cell only a complicated chemistry, and in variation only a change in the nature and arrangement of the chemical constituents; they either cling to a belief in "heredity," or (like Delage himself) replace it more or less completely by the effects of functional use and by chemical stimulation from without and from within. Yet others, like Felix Auerbach, still holding to a physical or quasi-physical theory of life, believe that in the living body the dissipation of energy is controlled by a guiding principle, as though by Clerk Maxwell's demons; that for the living the law of entropy is thereby reversed; and that life itself is that which has been evolved to counteract and battle

with the dissipation of energy. Berthold, who first demonstrated the obedience to physical laws in the fundamental phenomena of the dividing cell or segmenting egg, recognizes, almost in the words of John Hunter, a quality in the living protoplasm, *sui generis,* whereby its maintenance, increase and reproduction are achieved. Driesch, who began as a "mechanist," now, as we have seen, harks back straight to Aristotle, to a twin or triple doctrine of the soul. And Bergson, rising into heights of metaphysics where the biologist, *quâ* biologist, can not climb, tells us (like Duran) that life transcends teleology, that the conceptions of mechanism and finality fail to satisfy, and that only "in the absolute do we live and move and have our being."

We end but a little way from where we began.

With all the growth of knowledge, with all the help of all the sciences impinging on our own, it is yet manifest, I think, that the biologists of to-day are in no self-satisfied and exultant mood. The reasons and the reasoning that contented a past generation call for reinquiry, and out of the old solutions new questions emerge; and the ultimate problems are as inscrutable as of old. That which, above all things, we would explain baffles explanation; and that the living organism is a living organism tends to reassert itself as the biologist's fundamental conception and fact. Nor will even this concept serve us and suffice us when we approach the problems of consciousness and intelligence and the mystery of the reasoning soul; for these things are not for the biologist at all, but constitute the psychologist's scientific domain.

In wonderment, says Aristotle, does philosophy begin,[9] and more than once he rings the changes on the theme. Now, as in the beginning, wonderment and admiration are the portion of the biologist, as of all those who contemplate the heavens and the earth, the sea, and all that in them is.

And if wonderment springs, as again Aristotle tells us, from ignorance of the causes of things, it does not cease when we have traced and discovered the proximate causes, the physical causes, the efficient causes of our phenomena. For beyond and remote from physical causation lies the end, the final cause of the philosopher, the reason why, in the which are hidden the problems of organic harmony and autonomy and the mysteries of apparent purpose, adaptation, fitness and design. Here, in the region of teleology, the plain rationalism that guided us through the physical facts and causes begins to disappoint us, and intuition, which is of close kin to faith, begins to make herself heard.

And so it is that, as in wonderment does all philosophy begin, so in amazement does Plato tell us that all our philosophy comes to an end.[10] Ever and anon, in presence of the *magnalia naturæ,* we feel inclined to say with the poet:

οὐ γάρ τι νῦν γε κἀχθὲς, ἀλλ' ἀεί ποτε
ζῇ ταῦτα κοὐδεὶς οἶδεν ἐξ ὅτου 'φάνη.

"These things are not of to-day nor yesterday, but evermore, and no man knoweth whence they came."

I will not quote the noblest words of all that come into my mind; but only the lesser language of another of the greatest of the Greeks: "The ways of His thoughts are as paths in a wood thick with leaves, and one seeth through them but a little way."

D'Arcy Wentworth Thompson

PROSPECTIVE POPULATION OF THE UNITED STATES

Various estimates of the probable or possible future population of the United States

[9] "Met.," I., 2, 982*b*, 12, etc.

[10] Cf. Coleridge, "Biogr. Lit."

have been made, chiefly on the basis of extrapolation from figures of past growth in comparison with past and present population of other countries, and generally on the assumption that the sources of life and habitability are either unlimited or limited only by land area. One of the latest and most comprehensive estimates is that of Henry Gannett, geographer of the tenth, eleventh and twelfth censuses;[1] it was made without reference to limitation of sources of life, but in the light of the decreasing percentage increment of population shown by records of this and other countries. His figures for prospective increase are essentially arbitrary, decreasing from 21 per cent. during the decade 1900–1910[2] to 5 per cent. for the decade 2090–2100, giving populations of 90,000,000 in 1910, about 250,000,000 in 2000 and 500,000,000 a century later. Thus far no comprehensive extrapolations based on the thirteenth census appear to have been made.

Recent researches tend to indicate that the assumption of unlimited resources, or of resources limited only by land area, is unwarranted; for while the mineral resources of the United States are vast, while the forests are renewable and the farms susceptible of large increase in productivity, while the atmosphere gives little threat of exhaustion (despite the gloomy anticipations of Sir William Crookes and others concerning the stock of nitrogen), and while the available sun-power is thus far used to but a small fraction of its capacity, a practical limit to the productivity and habitability of the country is fixed by limitation in the water supply—and it is worth while to consider prospective population in the light of this limitation.

Standards for the use of water in relation to crop production and the maintenance of human existence arise under irrigation in arid regions, where water is measured more carefully and balanced more exactly against plant and animal life than in humid lands. Here 25 acre-feet of water properly used in agriculture or horticulture will sustain a family of five for a year, with the requisite surplus production for exchange; the best results follow application of the water on five acres of land to an aggregate of five feet in depth as needed during the season. Using water in this way, the rural population is one per acre, or 640 per square mile, stated in terms of land; but it is justly measured only as one for each 5 acre-feet (6,800 tons) of that menstruum which alone renders land productive.

The standards fixed in arid regions are not greatly different from those arising of late in humid lands. Hellriegel in Germany and King in this country have shown that crop plants require for their growth a quantity of water, measured by transpiration, averaging from 300 to 600 (with a mean of about 450) times the weight of the plants after drying; and common field experience indicates that in addition to the moisture passing through the plants the soil requires an even larger quantity to maintain a texture suitable for crop growth —much of which passes away through evaporation and seepage. On this basis "the agricultural duty of water" in this country has been formulated as *the production of one-thousandth part of its weight in average plant crop.*[3] Reckoning human food and drink on this basis, and assuming that meats require (chiefly in the growth of plants used as feed for the animals) ten times the quantity of water represented in vegetal food, it appears that the adult who eats 200 pounds each of bread and beef in a year consumes something like a ton of water in drink and the equivalents of 400 tons in bread and 4,000 tons in meat, or 4,401 tons in all—figures corresponding fairly with the results of intensive agriculture in arid districts. Accordingly, the

[1] Report of the National Conservation Commission (Sixtieth Congress, Second Session, Senate Document 676), 1909, Vol. 2, pp. 7–9.

[2] Perhaps through misprint, Gannett's increment for this decade does not correspond with the population figures; it is put at 21 per cent.—the rate subsequently determined by the Thirteenth Census —though his estimate of 90,000,000 is only 19.2 per cent. above the 75,569,000 (or 18.4 per cent. above the 76,000,000) appearing in his tables.

[3] "Yearbook of the Department of Agriculture," 1910, pp. 169–176; Bureau of Soils Bulletin 71, 1911, pp. 7–14.

"duty of water" considered in relation to human population may be stated roughly as *the maintenance of a human life a year for each 5 acre-feet used effectively in agriculture.*

Now mainland United States (*i. e.*, the chief body of our territory, exclusive of Alaska and the insular possessions) comprises something over 3,000,000 square miles, or somewhat less than 2,000,000,000 acres of land; yet the annual rainfall—the sole original source of fresh water—averages barely 2½ feet (30 inches), or hardly 5,000,000,000 acre-feet. So while the land area, if peopled to the density of Belgium (over 640 per square mile), would carry a population of 2,000,000,000, the water supply suffices for only 1,000,000,000.

Of course all these figures are but approximations; yet they indicate that the method of measuring capacity for population in terms of land area is adapted only to countries in which the water supply is ample, and that in this and most other countries estimates can safely be based only on the quantity of water available for the production of those staples of life used in food and clothing. Water is indeed the primary resource. In plant life it is essential to germination, to tissue-making, to all growth; and far the greater part of the average growing plant consists of water, chiefly in circulation. For men and other animals water is the leading food; the average human ration is some 6 pounds daily, 4½ liquid and 1½ nominally solid, but actually more than one third water—*i. e.*, fully five sixths of the sustenance (and indeed a like proportion of the bodies) of human beings is water. Within the body there is no assimilation or metabolism in the absence of water, nor does germination or any other vital process take place without it or apparently otherwise than as a manifestation of its inherent properties. The measure of water is the measure not merely of productivity but of vitality; and disregarding other climatal factors, the habitability of every country on the globe is determined by the presence or absence, and finally by the quantity, of water distilled from the oceans, circulating through the atmosphere, and descending on the land.

Considered in relation to natural water supply, mainland United States comprises three divisions: (1) the humid section, or eastward states—31 in number—extending from the Minnesota-Louisiana tier to the Atlantic, commonly viewed as the chief part of the country though forming only two fifths of its area; (2) the sub-humid section, or 6 median states from the Dakotas to Texas, containing a fifth of the area of the country; and (3) the semi-arid section, or westward states—11 in number, including Arizona and New Mexico—making up the remaining two fifths of the territory.

Over the humid section the mean annual rainfall ranges from about 25 inches in Minnesota to 55 in Mississippi and over 70 in the southern Appalachians, averaging some 48 inches, or four fifths that required for full productivity. In round figures, the 800,000,000 acres receive annually over 3,000,000,000 acre-feet of rainfall, or nearly two thirds of the entire supply of the country, and now sustain a population of 75,000,000. The prospective population, reckoned on the basis of 5 acre-feet of water supply per capita annually, may reach 600,000,000, or 8 times that of the present; so far as may be foreseen, that population could best be sustained by intensive cultivation to such degree that each ten-acre lot would yield materials for food and clothing for a family of five direct producers, and perhaps an equal number of urban residents living by secondary production or incidental industries.

Over the 400,000,000 acres comprised in the median states the rainfall averages scant 30 inches, or half the water required for full productivity (though as shown by Gannett from 60 per cent. to over 80 per cent. of it falls during the six summer months). While adapted only to extensive agriculture, the capacity of this section for production of staples is far beyond the present yield; if the entire water supply (including the natural sub-irrigation from the Rocky Mountains) were effectively used, it would sustain a family to

each 40-acre lot with another living in town or depending on transportation for livelihood; when the aggregate population would reach 200,000,000, or twenty times that of to-day.

Over the 800,000,000 acres of the westward states the rainfall ranges from less than 2 to over 100 and averages about 12 inches, aggregating some 800,000,000 acre-feet yearly, or a fifth of the productivity standard. The entire water supply would suffice for the intensive cultivation of only 160,000,000 acres; but the present and prospective utilization is highly efficient (the "return water" from irrigation is used over and over again), so that the possible population may be estimated at 200,000,000, or thirty times that of to-day.

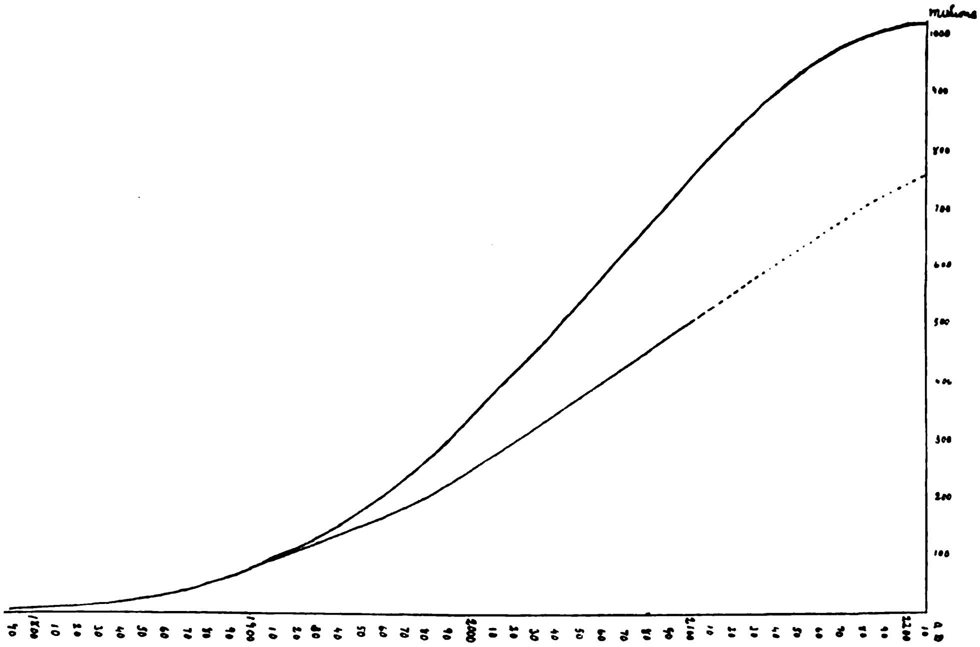
These estimated populations are comparable with present populations in several countries. The 600,000,000 for the eastward states is about one fifth greater than that of China (438,214,000) and Japan (50,751,919) combined; the density is 500 per square mile, almost exactly that of Lombardy (495), little above that of the Netherlands (467), only 1⅓ times that of the United Kingdom (372), little more than three fourths that of Belgium (649), two thirds that of Saxony (778) and half that of (settled) Egypt (931). The 200,000,000 for the median states is considerably less than the population of British India (231,855,583); the density is 333 per square mile, below that of Japan (344) but above that of Alsace-Lorraine (324), Germany (311) and Italy (310), not greatly above that of China (266), and little more than half that of Java (595). The 200,000,000 for the westward states would give a density of 167 per square mile, the same as that of Denmark and Hungary and considerably below that of France (190), Switzerland (234), Bavaria (223), Formosa (226), Austria (246) or Poland (232).[4] The aggregate of 1,000,000,000 for mainland United States is comparable with the present population of Asia or twice that of Europe; the mean density is 333 per square mile, about mid-way between that of the United Kingdom and Germany, little more than half that of Belgium, less than half that of Saxony and only about one third that of Egypt.

The rate of increase in population to the limit fixed by water supply may be extrapolated roughly; and despite the favorable prepossesion due to Gannett's experience (greater perhaps than that of any other census student in the country), his estimate of the decennial increment may be somewhat increased—for several reasons. In the first place his estimate for the 1910 population, although made but a few months in advance of enumeration and in the light of the approximate figures of late prepared in the Census Office, was nearly 2,000,000 too low. Again, the advance during recent years in etiology, sanitation, surgery and other factors of health and viability have virtually given a new lease of life to mankind in this and other countries, while the influence of enlightenment is rapidly spreading, so that (in spite of a declining birth-rate) the population of the world generally appears to be increasing at an unprecedented rate. Furthermore, in this country primary production (*i. e.*, of foodstuffs and textiles) has within a few years past increased with unparalleled rapidity, perhaps more rapidly than manufacturing or transportation in their palmiest days; taking the value of the farm products of 1899 at 100 as a basis, the relative value for 1905 was 133; for 1906, 143.4; for 1907, 158.7; for 1908, 167.3; for 1909, 182.8, and for 1910, 189.2—the absolute value for this last year reaching $8,926,000,000.[5] Meantime the influx of prolific immigrants continues, and a large proportion of them are finding their way into rural districts and primary industries where the conditions are favorable to family life. These various considerations warrant the expectation of a vigorous and sustained growth in the population of this country for many years.

It is true that apparent indications of ap-

[4] The figures are taken (the population-density generally computed) from areas and populations in the "Statesman's Yearbook," 1910, supplemented by records for 1910 compiled by Gannett (*Nat. Geog. Mag.*, Vol. XXII., 1911, p. 785).

[5] "Yearbook of the Department of Agriculture," 1910, p. 10.



proaching paralysis have arisen, *e. g.*, in a cost of living exceeding that of any other age or country, in diminishing exports of foodstuffs, etc.; yet it seems probable that these conditions mark a temporary rather than permanent disturbance of economic balance between primary and secondary industries—a disturbance destined to be progressively adjusted, unless current signs of the times be wholly misleading. The primary industries—the production of materials for food and clothing chiefly from the soil through utilization of the natural water supply—dominated the growth of the country from 1776 to about 1850; but especially during the half-century 1850–1900 the secondary industries of manufacturing and transportation expanded beyond all precedent or parallel, until the annual value of manufactures arose to more than twice that of the primary staples, and the cost of transportation increased to a quarter or a third of the value of primary production. Despite this industrial revolution, a reasonable balance was long maintained through rapid agricultural expansion and the bringing of virgin fields under cultivation, whereby the secondary workers were fed and clothed without appreciable burden on the resources of the country. Of late this method of maintaining the economic balance has failed, since the virgin fields available for settlement and cultivation in the old way are exhausted—and the industries of the United States have grown top-heavy in manufacturing and transportation. The burden of manufacturing is the greater by reason of a tariff adapted neither to the raising of revenue nor to the protection of American workmen so much as the concentration of capital; yet indications are clear that within a year this burden will be materially reduced by revision of the tariff laws. The burden of transportation has arisen chiefly with the growth of railways in property and power until the simple economic law of supply and demand has been replaced by the arbitrary formula "what the traffic will bear," which largely controls production; the annual cost of railway transportation (of which some 70 per cent. is freightage) is now about $2,700,000,000, equivalent to an impost of $5.25 per acre on the 475,000,000 acres of improved land in this country, or a personal tax of $150 per family (fully one third of the average cost of

PAST AND PROSPECTIVE POPULATION OF MAINLAND UNITED STATES

Year A.D.	Present Estimate			Gannett Estimate		
	Population	Increase		Population	Increase	
1790	3,929,214	....	......	3,929,000	....	......
1800	5,308,483	1,379,269	=35.1%	5,308,000	1,379,000	=35%
1810	7,239,881	1,931,398	36.4	7,240,000	1,931,000	36
1820	9,638,453	2,398,572	33.1	9,638,000	2,399,000	33
1830	12,866.020	3,227,567	33.5	12,866,000	3,228,000	33
1840	17,069,453	4,203,433	32.7	17,069,000	4,203,000	33
1850	23,191,876	6,122,423	35.9	23,192,000	6,122,000	36
1860	31,443,321	8,251,445	35.6	31,443,000	8,251,000	36
1870	38,558,371	7,115,050	22.6	38,558,000	7,115,000	23
1880	50.155,783	11,597,412	30.1	50,156,000	11,597,000	30
1890	62,947,714	12,791,931	25.5	62,622,000	12,466,000	25
1900	75,994,575	13,046,861	20.7	75,569,000	12,946,000	21
1910	91,972,266	15,977,691	21.0	90,000,000		21(?)
1920	110.000,000	18,000,000	20	104,000,000		16
1930	131.000,000	21,000,000	19	119,000,000		14
1940	155,000,000	24,000,000	18	134,000,000		13
1950	181,000,000	26.000,000	17	150,000,000		12
1960	210,000,000	29,000,000	16	167,000,000		10
1970	241,000,000	31,000,000	15	184.000,000		10
1980	275,000,000	34,000,000	14	202,000,000		10
1990	311,000,000	36,000,000	13	225,000,000		11
2000	348,000,000	37,000,000	12	249,000,000		11
2010	386,000,000	38,000.000	11	274,000,000		10
2020	425,000,000	39,000,000	10	299,000,000		9
2030	463,000,000	38,000,000	9	325,000,000		9
2040	505,000,000	42,000,000	9	350,000,000		8
2050	545,000,000	40,000,000	8	375,000,000		7
2060	589,000,000	44,000,000	8	400,000,000		7
2070	630,000,000	41,000,000	7	425,000,000		6
2080	674,000,000	44,000,000	7	450,000,000		6
2090	714,000,000	40,000,000	6	475,000,000		5
2100	757,000,000	43,000,000	6	500,000,000		5
2110	795,000,000	38,600,000	5	*525,000,000*		*5*
2120	835,000,000	40,000,000	5	*551,000,000*		*5*
2130	868,000.000	33,000,000	4	*573,000,000*		*4*
2140	903,000,000	35,000,000	4	*596,000,000*		*4*
2150	930,000,000	27,000,000	3	*620,000,000*		*4*
2160	958,000,000	28,000,000	3	*645,000,000*		*4*
2170	977,000,000	19,000,000	2	*671,000,000*		*4*
2180	997,000,000	20,000,000	2	*691,000,000*		*3*
2190	1,007,000,000	10,000,000	1	*712,000,000*		*3*
2200	1,017,000,000	10,000,000	1	*733,000,000*		*3*
2210	1,017,000,000	0	0	*755,000,000*		*3*

living); but already the railways are passing under regulation in the public interest by the Interstate Commerce Commission, while with that proper development of waterways destined to come before the next decennial census the aggregate cost of freight movement will be reduced 20 per cent. or 30 per cent. So on the whole any apparent paralysis in growth arising in imperfect economic balance would seem to be more apparent than real, and at the worst of temporary character.

The decennial percentage increment of population decreases normally with growth. During the twelve decades covered by the United States census the increments have varied from 36.4 per cent. (1800–1810) to 20.7 per cent. (1890–1900), averaging 30.4 per cent.; the mean for the earlier six being 34.4 per cent. and for the later six 25.9 per cent. The decreases have not been uniform; during the second decade there was a slight increase, during the sixth a decided increase, during the ninth (following the civil war decade) a still greater increase, and during the twelfth a slight increase (from 20.7 per cent. to 21 per cent.).

In the extrapolation based on (1) past growth, (2) current promise of prospective growth and (3) limitation of growth by water supply, it may be assumed that the percentage increment will diminish steadily at the rate of 1 per cent. during each decade for a century, and then more slowly (1 per cent. during each two decades) for two centuries more, when the population limit fixed by water supply may be reached. Reckoned on this assumption, the prospective population is shown in the accompanying table and diagram (the figures from 1790 to 1810 from Census Bulletin 109), in which Gannett's estimates are introduced for comparison, and extended from A.D. 2100 to A.D. 2210 on the basis of percentage increments decreasing conformably with his figures for the two preceding centuries.

It is true that in the era of commercial interchange on which the world has fairly entered no country exists wholly unto itself, but subsists in part on the resources of other lands and in prospectively increasing degree on those of the waters; theoretically, the population-estimate for any country should take account of the capacity of other countries for yielding and exchanging necessaries of life—*i. e.*, the materials for food and clothing; but practically, the cost of exchange (including transportation) imposes a burden directly on the consumers and less directly on the producers of commodities, and if these are prime necessaries this burden tends quickly to become unbearable—when the people on whom it rests must cease increasing and may even decrease until an economic balance is attained. Yet by reason of areal extent and variety of resources, mainland United States is potentially self-contained in exceptional degree (unexcelled natural wealth in materials for manufacturing and the development of power are combined with a large capacity for

producing prime necessaries), so that prognostications of growth in this country are apparently safer than in any other. The very extent of territory contributes to its self-content and isolation; its magnificent distances involve such cost in transportation (and must continue to do so, despite prospective improvement in facilities) as to limit interchange between producing areas and ports, and thus to restrict foreign commerce; every transcontinental traveler must be impressed by the vast tracts in the westward states unproductive and nearly uninhabitable because of aridity, yet few realize that with half its area and the present water supply equably distributed mainland United States could sustain a population equal to its present capacity and maintain freer foreign commerce by reason of the reduced average distance and cost of domestic traffic. The various factors affecting any forecast of future production and population in this country indicate that the growth will be exceptionally independent and presumably uniform. The highest numerical increment in the accompanying tabulated estimate (for a century and a half hence) is 44,000,000 in a decade, only 2¾ times that of the last decade with an estimated population sevenfold greater. The maximum estimated population of about 1,000,000,000 is less than eleven times that of 1910; and any excess in the estimated increments may be balanced by extending the estimated date (about A.D. 2200) a few decades further into the future. By way of comparison it may be noted that since the rainfall on the lands of the globe is some 30,000 cubic miles (or 100,000,000,000 acre-feet), the maximum world population, computed on the same basis, is 20,000,000,000, or about thirteen times the present 1,500,000,000.

Whatever the probability of error in the forecast, it would seem timely to consider the prospective population of this and other countries in the light of the leading lessons of anthropology, (1) that the development of mankind is progressive, (2) that the distinctive attribute of the human realm is mentality and (3) that through cumulatively advancing mentality man (unlike other organisms) adjusts himself to environment in increasing degree by subjugation of lower nature. Accordingly, the capacity for population of any country during any generation depends not merely on the natural resources but on these resources as modified and adapted to human needs by human genius; while the food quest is fundamental, the sources of food (and of clothing as well) for enlightened folk are not the natural fauna and flora but cultivated and virtually artificialized plants and animals; while tools and machines and mechanical power are necessaries of industrial activity, their sources are no longer those found ready-made in nature but are secondary products gained by artificial conversion of natural materials and forces—and no end to this reconstruction of nature is in sight save the limitation to life first in water supply and then in other constituents of atmosphere and earth. Meantime the power and efficiency of humanity are advancing; throughout the world men now meet in amity rather than instinctive enmity as in savagery and barbarism, and while there will yet be bloody battles before warfare is made so sanguinary by mechanical and chemical devices that mankind will revolt against it, the current trend is toward national no less than individual obedience to law and hence toward international peace; famine grows less fatal with advancing solidarity of peoples; pestilence is passing with the advance of science and philanthropy; health and happiness and viability have increased almost uninterruptedly from the prime to the present, and give every promise of continued increase; and most significant of all, the social and governmental institutions of all countries are steadily rising from primitive types in which the lives of the many were at the mercy of a favored few to that plane on which all lives are alike sacred—indeed the modern and prospective governmental form is but the organized expression of the knowledge and opinions and sentiments—*i. e.*, of the essentially human traits—of a constituent citizenry. In the light of past progress, it is the manifest destiny of the temperate and tropical zones to

be subjugated and controlled for human welfare through a continued and cumulative conquest limited only by capacity for yielding necessaries of life. While other limiting factors may arise as mentality extends and intensifies, that most evident to-day in this and several other countries is the water supply; yet even this barrier may not prove insuperable by advancing invention so long as the constituents of water abound in other combinations in the external earth-crust. Whatever the uncertainties, any definite estimate of future population made in the light of limitations arising in current knowledge of resources is more likely to be found too small than too large as knowledge and command over nature advance with the progressive development of mankind.

W J McGee

THE SILLIMAN LECTURES

The Silliman lectures for 1911 will, as already announced, be given at Yale University by Professor Max Verworn, of the University of Bonn. They will be given in Lampson Hall at five o'clock on successive days beginning on Monday, October 9. The subjects are as follows:

I. Historical Observations on the Doctrine of Irritability.
II. The Meaning of Stimuli.
III. The Special Characteristics of Stimuli.
IV. The General Effects of Stimulation.
V. The Analysis of Excitation.
VI. The Conductivity of Excitation.
VII. Refractory Period and Fatigue.
VIII. The Interference of Excitation.
IX. The Interference of Excitation. (*Continued.*)
X. The Processes of Depression.

The preceding lectures on the Silliman foundation have been:

1903. Professor Thomson, Cambridge University: Electricity and Matter.
1904. Professor Sherrington, University of Liverpool: Integrative Action of the Nervous System.
1905. Professor Rutherford, McGill University: Radio-active Transformations.
1906. Professor Nernst, University of Berlin: Applications of Thermodynamics to Chemistry.
1907. Professor Bateson, Cambridge University: The Problems of Genetics.
1908. Professor Penck, University of Berlin: The Problems of Glacial Geology.
1909. Professor Campbell, Lick Observatory, University of California: Stellar Motions.
1910. Professor Arrhenius, University of Stockholm: The Theories of Solutions.

SCIENTIFIC NOTES AND NEWS

Professor W. S. Eichelberger, director of the Nautical Almanac, will represent the United States at a conference of the directors of the National Nautical Almanacs to be held at Paris from October 23 to 28.

At Harvard University Professors W. M. Davis (geology), P. H. Hanus (education), E. V. Huntington (mathematics) and E. B. Holt (psychology) have leave of absence from the university for the academic year 1911–12; Professors Theobald Smith (comparative pathology), George Santayana (philosophy), R. B. Perry (philosophy) and D. W. Johnson (physiography), for the second half-year.

The Hanbury gold medal of the British Pharmaceutical Society has been awarded to M. Eugene Léger, of the Hôpital St. Louis, Paris.

Dr. G. A. Hansen, president of the permanent international committee on leprosy, was one of the founders of the *Medicinsk Revue* in Norway in 1884. On the occasion of his seventieth birthday recently, as we learn from the *Journal* of the American Medical Association, the *Revue* issued a special *Festschrift* number in his honor with fifteen articles on various topics, especially leprosy and pellagra, all by Norwegian writers.

Professor Charles L. Edwards, of the University of Southern California, has been placed in charge of the abalone investigations instituted by the Fish and Game Commission of the state of California.

We learn from *Nature* that Mr. J. J. Nock has been appointed by the British secretary of

state for the colonies, on the recommendation of the Kew authorities, curator of the Hakgala Gardens, Ceylon.

MR. MARCONI has been elected president of the Junior Institution of Engineers in succession to Sir J. J. Thomson, F.R.S.

M. G. FAYET, of the Paris Observatory, has been appointed astronomer at the Nice Observatory, in succession to M. Simonin.

IT is stated in *Nature* that Dr. R. Karsten, lecturer in comparative religion in the University of Helsingfors, has started on an expedition to Gran Chaco and Bolivia for the purpose of making investigations on the sociology and religion of various tribes of natives, some of whom are little known, while others have never been visited. He will be accompanied by his cousin, O. Lindholm.

A BRONZE statue has been erected at Poleymeux, in the Rhone Department, France, in memory of Ampère.

MR. EDWARD WHYMPER, known for his explorations among the Alps, in the Andes and elsewhere, died at Chamonix on September 16, aged sixty-one years.

DR. LOUIS BRAUNDET, professor of anatomy at the medical school at Reims, has died from anthrax, contracted in the course of his professional duty.

THE Civil Service Commission will hold an examination for assistant forest ranger on October 23–24, 1911. The U. S. Department of Agriculture estimates that 400 eligibles will be needed during the field season of 1912. Assistant forest rangers are paid an entrance salary of $1,100 per annum. The examination will be held at National Forest headquarters in Alaska, Arizona, Arkansas, California, Colorado, Florida, Idaho, Kansas, Minnesota, Montana, Nebraska, Nevada, New Mexico, Oklahoma, Oregon, South Dakota, Utah, Washington and Wyoming. The law requires that, when practicable, forest rangers must be qualified citizens of the state or territory in which the national forest on which they are appointed is situated. Since the list of local eligibles must be exhausted before eligibles residing in other states can be appointed, the chance of citizens of outside states who go to National Forest states and take the examination to secure an appointment is small.

THE eleventh intercollegiate geological excursion will be held on October 13 and 14 in the vicinity of Boston under the direction of Professor A. C. Lane, of Tufts College. The north side of the Boston basin will be visited to study shore changes, salt marsh peat as evidence of subsidence, beach cusps, the gabbro diabase of Nahant and Medford, and the Cambrian contact zone. Further information may be obtained from the secretary, Professor Herdman F. Cleland, Williams College.

AT the last meeting of the Ohio State Archeological and Historical Society, G. F. Wright was elected president; E. O. Randall, secretary, and W. C. Mills, curator. The legislature at its last session, in addition to its ordinary appropriations for field work and general expenses, voted $100,000 for a museum building to be erected on the grounds of the State University at Columbus. also $40,000 for the erection of a fire-proof building in Fremont, Ohio, to preserve the valuable library of Americana and political documents left by the late President Hayes. This also secures to the state, for a public park, the grounds, to the extent of twenty-five acres, surrounding the homestead of ex-President Hayes.

THE meeting of the International Sanitary Conference to revise the provisions of the convention of 1903 for the prevention of the invasion and propagation of plague and cholera, is to take place in Paris on October 10 next.

FIFTY thousand dollars will be sought of congress by the Public Health and Marine Hospital Service for the suppression of pellagra. The annual report of Surgeon-General Wyman, soon to appear, will show the great strides that have been made by the disease in the last two years. It is said that it is increasing annually more than 100 per cent. It is said that there are in the south more than 10,300 cases.

WE learn from *Nature* that an agreement has been signed by the representatives of the

United Kingdom and Germany, the carrying into effect of which will mean a thorough investigation into the extent of sleeping sickness in the Gold Coast Colony, the Ashanti and northern Territory Protectorates, and Togoland. Each government will keep the other informed of the incidence, extent and possible spread of the disease in its territory, and will treat the other's native subjects free of charge; but each may impose restrictions on the frontier traffic and may prevent suspected sufferers from crossing its border. The agreement is for three years certain from December 1, 1911, and continues thereafter for yearly periods, unless denounced at least six months before the close of a year.

A REPORT on the geology of the Lake Superior region, by President C. R. Van Hise and Professor C. K. Leith, of the University of Wisconsin, has been published by the United States Geological Survey as Monograph 52. This monograph represents the survey's first attempt to cover the geology of the region in a single volume and forms at once a notable contribution to the literature of American geology and a guide book for the exploitation of the mineral wealth of the region. It covers 641 pages and contains chapters on all the iron and copper producing districts as well as full descriptions of the iron and copper ores. It includes accurate maps of all the districts and a general geologic map of the region. The illustrations number 49 plates and 76 text figures, comprising maps, sections, diagrams and halftone reproductions of photographs of ores and minerals.

A CIRCULAR, quoted in *Nature*, respecting the work of the Aberdeen University Bird-migration Inquiry has been issued by Professor J. Arthur Thomson and Mr. A. L. Thomson. The object of the movement is the collection of more definite information on migration by the method of placing aluminium rings on the feet of a large number of birds, in the hope of hearing of the subsequent movements of some proportion of the birds. The rings are inscribed with the address "Aberdeen University," and a number (or number and letter combination) different in each case. The rings are placed on young birds found in the nest, or on any old ones that can be captured without injury. The following extracts are taken from the circular above-mentioned: (1) "It is particularly requested that all who may shoot, capture or kill or even hear of any of our marked birds, should let us know of the occurrence. As accurate particulars of date and locality as possible are desired, but, above all, the number (or number and letters) on the ring. Indeed, except where it has been possible to reliberate the bird uninjured, the ring itself should always be sent, or the ring and foot, or even the whole bird. We always refund postage if asked to do so." (2) "We invite the cooperation in the actual work of marking of any who are specially interested, and have some knowledge of birds and also time and opportunity for the work. The necessary rings, schedules, postage stamps, etc., are supplied by us, without charge, and we undertake to let the marker know of each case of a bird marked by him being recovered, and to let him have copies of printed reports as far as possible."

A SERIES of analyses of the water of the Mississippi River made by chemists of the United States Geological Survey, reveals the changes in its character at different points. At Minneapolis the water of the Mississippi is very simple in character, being distinguished only by secondary alkalinity, primary salinity and very low secondary salinity or permanent hardness. At Moline, Ill., permanent hardness appears definitely among the properties of the Mississippi water, although it occupies a very subordinate position. At Chester, Ill., however, the character of the water appears to be greatly changed, for the analyses indicate that the proportion of primary salinity is much increased and the proportion of permanent hardness is more than doubled. This change is due to the highly saline waters received from the Missouri at a point between Quincy and Chester. From Chester to New Orleans the river water appears to undergo no permanent change in gen-

eral character. Additional contributions of saline waters from the west, received through Arkansas and Red rivers, suffice to maintain in the water of the lower Mississippi that high proportion of salinity first derived midway in its course from the Missouri River.

West of Koyukuk and Yukon rivers in Alaska a large area has long remained geologically unexplored. In a portion of this region an exploration party from the United States Geological Survey worked during the season of 1909, and the results of the studies there carried on and extended as far as Council, in Seward Peninsula, are set forth in Bulletin No. 449 just issued by the survey. The party consisted of Philip S. Smith and H. M. Eakin, geologists of the survey and authors of the report, A. G. Winegarden, packer, and a cook. Supplies for a month were shipped to Nulato, the point from which the expedition set out, and other supplies, sufficient to last the rest of the season, were sent to Nome and then transported to the mouth of the Koyuk and there cached to await the arrival of the party. The area traversed by this party was selected for survey because it was thought that the metamorphic rocks of the Seward Peninsula might occur within it, which would give presumption of the presence of gold deposits. In addition to exploring the region east of Norton Bay the party carried the topographic and geologic mapping into the southeastern part of the Seward Peninsula, thus extending the areas mapped by the Geological Survey in earlier years. The report is a volume of 140 pages, describing the topography and geology of the area and containing notes on its climate, vegetation, game and fish. Some 40 pages are devoted to the mineral resources—placer and lode gold deposits and prospects, and silver, lead, copper and coal. It is illustrated with photographs and brief sketch maps and contains also a topographic reconnaissance map of southeastern Seward Peninsula, on the scale of four miles to the inch, a colored geologic map of the same area and a colored geologic map of Nulato-Norton Bay region, on the scale of 8 miles to the inch.

Fluorspar, one of the lesser minerals, has come to occupy a comparatively important place in every-day affairs. It is used in the manufacture of glass, of enameled and sanitary ware, in refining antimony and lead, in the production of aluminum, and as a flux in blast furnaces and in the manufacture of steel in basic open-hearth furnaces. The production of open-hearth steel alone in 1910 was over 15,000,000 long tons. The production of fluorspar, according to Ernest F. Burchard, of the United States Geological Survey, in a report on fluorspar and cryolite just issued, increased from 18,450 short tons in 1900, valued at $94,500, to 69,427 tons in 1910, valued at $430,196. There was an increase in 1910 of 37 per cent. in quantity and 47 per cent. in value over the figures for 1909. The deposits which have been exploited are in Arizona, New Mexico, Colorado, Illinois, Kentucky, Tennessee and New Hampshire. Illinois is much the heaviest producer. There was also imported in 1910, according to Mr. Burchard, 42,488 short tons, valued at $135,152. Mr. Burchard's report contains, in addition to the statistics of the industry, a discussion of the methods of mining and milling fluorspar as well as a description of recently discovered high-grade deposits in New Mexico.

A volume containing the reports for the year 1909–10 from those universities and university colleges in Great Britain which participate in the parliamentary grant has been issued as a blue-book and an abstract is given in the London *Times*. The introductory report of the Board of Education, which is signed by Mr. Runciman, Mr. Trevelyan and Sir Robert Morant, deplores the fact that, apart from the recent munificent gifts to Reading University College, the endowments provided by private benefaction during the period have not been comparable in magnitude and importance with those of the late Sir Alfred Jones, Mr. Otto Beit, M. Albert Kahn or Mr. W. H. Lever, to which reference was made in the last report, although there probably was never a time when university education was in greater need of encouragement. The apathy of the public at large is

only too frequently reflected in the attitude of local authorities, some of the most important of whom give far less than their proper share of support to the universities, and in one or two instances the maintenance at their present level of the grants made by local education authorities has been endangered. For the financial year 1909–10 the amount of grant actually paid by the treasury to university colleges in England was £96,100, and for the year 1910–11 £101,250. In the year 1909–10 £15,000 was added to the grant in aid of university education in Wales. Dealing with the problem of university education in the metropolis, the introductory report dwells on the need for a proper scheme of coordination, which it holds to be especially urgent in the case of higher technological and professional work, and declares that until the problem has been adequately dealt with it is almost impossible to deal wisely with even the most urgent claims for further development. With regard to finance, the report shows that nearly 33 per cent. of the income of English colleges is derived from fees, about 15 per cent. from endowments, a little over 14.5 per cent. from grants from local education authorities and 28 per cent. from the exchequer.

For an anthropological research expedition to the islands of Normandy, Fergusson and Goodenough, in British New Guinea, as we learn from the London *Times*, funds are being provided out of the Oxford University common fund and by several of the colleges. The work has been undertaken by Mr. David Jenness, of Balliol College, who proposes, unaccompanied, to spend a year amongst people who are admittedly cannibals. It is stipulated by the university, in contributing to the expedition, that the museum shall have the first offer of articles of interest which may be obtained. Assistance has been promised by the missionaries on Goodenough Island, including the use of a boat and native oarsmen. The first few weeks will be spent in cruising around the islands endeavoring to get on friendly terms with the people and in studying the trade relations. As the natives have sea-going canoes and trade with the neighboring coast and the island of Trobriand, 100 miles away, Mr. Jenness will endeavor to obtain the good will of one of the chiefs and settle down for about a year. Later he will proceed on a mission boat to Rossell Island, at the eastern end of the Louisiade Archipelago, to study some ethnological problems concerning the relationships of Oceanic peoples. Mr. Jenness has been provided with the latest scientific instruments, including a phonograph for recording native songs and speech.

UNIVERSITY AND EDUCATIONAL NEWS

The Institute of Anatomy of the Jefferson Medical College, erected at a cost of $125,000, by Mr. Daniel Baugh, was dedicated on September 26. Addresses were made by Dr. E. A. Spitzka, professor of applied anatomy in the college, and Dr. George A. Piersol, professor of anatomy at the University of Pennsylvania.

The late Dr. William Flynn, of Marion, has willed his entire estate, valued at about $30,000, to the Indiana Medical College, in which he was a member of the faculty for many years.

Among the public bequests made by Mr. George M. Pullman was that of $1,200,000 for founding and endowing the Pullman Free School of Manual Training at Pullman, Ill. This fund has increased to more than $2,500,000. The first step toward founding the school was the purchase, in 1908, of a campus of forty acres within the limits of the town of Pullman at a cost of $100,000. Mr. Laenas Gifford Weld, until recently professor of mathematics and dean of the faculty of liberal arts in the Iowa State University, was appointed principal in May and entered upon his new duties September 1. He will visit the leading technical and trade schools in this country and in Europe before the preparation of definite plans is undertaken.

The medical department of Tulane University announces the inauguration of a department of tropical medicine, hygiene and preventive medicine, beginning October 1, in charge of Dr. Creighton Wellman and staff. Laboratory courses, clinics and lectures will be given in the regular junior and senior classes;

in addition graduate courses are offered, for which certificates will be issued, counting toward special degrees to be created.

A NEW university is to be founded at Perth, Western Australia. Mr. Cecil Andrews, who represents the commission charged with carrying out the project, is at present visiting the universities of this country.

DR. GEORGE H. DENNY, president since 1902 and previously professor of Latin at Washington and Lee University, has been elected president of the University of Alabama.

DR. A. S. PEARSE goes to the St. Louis University School of Medicine as associate professor of biology.

AT the University of Maine, Mr. Earle O. Whittier has been appointed instructor in chemistry and Mr. Clayton Urey, instructor in physics.

New appointments in the faculty for the University of Montana for 1911–12 are as follows: Honorable John B. Clayberg, honorary dean and professor of Montana practise and mining irrigation law; H. W. Ballantine, acting dean and professor of law; Philip S. Biegler, assistant professor of electrical engineering; George H. Cunningham, instructor in mechanical engineering; G. A. Gross, instructor in engineering shops.

THE faculty of Middlebury College, Vermont, has increased from twelve to twenty-five in the last four years. There are eight new instructors this year, all but two of them filling new positions. These include: Avery E. Lambert, Ph.D., assistant professor of zoology, from the State Normal School, Framingham, Mass.; C. Allan Lyford, A.M., assistant professor of geology from Clark College; George H. Cresse, A.M., assistant professor of mathematics; Ray L. Fisher, assistant professor of physical education and director of athletics; Irving W. Davis, instructor in pomology.

DR. DUNCAN GRAHAM has been appointed lecturer on bacteriology at the University of Toronto.

DR. ALEX. FINDLAY, special lecturer at the University of Birmingham, has been appointed professor of chemistry in the University of Wales at Aberystwyth.

DISCUSSION AND CORRESPONDENCE

A CARBONIFEROUS FLORA IN THE SILURIAN?

UNDER the caption "The Oldest Silurian Flora" Dr. G. F. Matthews[1] has recently set forth geological conclusions and correlations, which, if true, mean nothing less than the condition implied by the above title.

History shows, even in the literature of geology and paleontology, that if error be reiterated with sufficient frequency and vociferation it will, unless disproved or controverted, gradually gain credence and eventually tacit acceptance. Sometimes, therefore, as in the present instance, so persistent is the erroneous utterance, it unfortunately becomes necessary to repeat the protest; and in order that the paleobotanical misinformation contained in Dr. Matthews's last article may not, as in some preceding instances, find unopposed entrance to the text-books, the common dogma of geology, it obviously becomes somebody's unpleasant duty to challenge his conclusions. This I regretfully do, the seemingly inane title of this note being an epitome of the issue.

It concerns mainly the flora and the age of the "fern ledges"—the "Cordaites shale" and the "Dadoxylon sandstones"—at St. John and Lepreau, near the Bay of Fundy, which Sir William Dawson more than forty years ago referred to the Devonian, and which Matthews now declares are, in part at least, Silurian. Soon after the publication of Dawson's papers mild protests were offered by Geinitz and several others at placing beds with such distinctly Carboniferous plants and insects in the Devonian. About thirty years later, when both the Devonian and the Carboniferous floras were far better known and their stratigraphic significance more definitely determined, opposition was again made by Mr. Robert Kidston, the highest British authority on the Paleozoic floras, and myself, each of whom had examined collections from the disputed beds. Each, wholly without knowledge of the other's views, at once referred the flora to the Carboniferous, both regarding the plants as probably belonging

[1] *Bull. Nat. Hist. Soc. New Brunswick,* No. 28, 1910, pp. 241–249.

to the Pottsville group, which covers the "Lower" and "Middle Coal Measures" of the British Isles. As to their Carboniferous age neither of us had any doubt; and I think I speak correctly for Mr. Kidston when I add that the extensive discoveries of the past ten years, though without exception confirmative of our correlations, can have made us but little more certain of our ground. In reply we have heard repeated the arguments of the "sixties," that the flora differs from all other Devonian floras because it is estuarine or marsh, and that the relative metamorphism and the stratigraphy of the beds unmistakably prove their Devonian age.

It is impossible here to give particulars or even the substance of the paleobotanical evidence. Briefly, it is clear that the flora comprises an association of genera characteristic of the Upper Carboniferous; that many of the species are identical with plants in the Pottsville of the Appalachian trough, while other forms differ no more than may naturally be expected in view of the remoteness and isolation of the basin; that all types characteristic of the Devonian, including estuarine and delta beds in other parts of the world, are absent; that the evidence of the associated animal fossils is in agreement with that of the plants; that the metamorphism is not greater than in the Rhode Island Coal Measures; and that, in this region of extensive Pleistocene and sea concealment, and of folding, faulting and metamorphism, the stratigraphic evidence presented is neither clear nor conclusive.

We are now told that the floras ("faunas") of the "fern ledges" are Silurian! They are said to differ from all other pre-Carboniferous floras because they are "delta" floras! To be more explicit, the plant-bearing delta deposits are correlated by him with other beds in different regions shown by their marine remains to be Silurian. The "Dadoxylon sandstones" are accordingly referred to No. 2 of the Mascarene Silurian series, while the "Cordaites shales" are said to belong to No. 3 of the same series. In other words, Dr. Matthews now concludes that the "fern ledges" are of Clinton and Niagara ages. By no process can he possibly be interpreted as permitting the youngest plant beds to be above the Helderberg. Hence, if any paleobotanist has at any time entertained sufficient confidence in the stratigraphic arguments to cause real anxiety lest the "fern ledges" might possibly be Devonian, the new stratigraphic "correlation" must certainly put him completely at ease.

The almost astounding faunal discoveries brought to light by Dr. Walcott in the Canadian Rockies should deeply impress on every paleontologist the virtue of conservatism; but the possible analogies with the "fern ledges" floras are very limited. The wonderfully preserved fauna exhibiting so wide a systematic range and such singular biologic relations in the Cambrian of Canada nevertheless comprises characteristic Cambrian fossils. On the other hand, to assume that under local environmental conditions (which there is no reason for regarding as unique) there were developed at one known spot in the world not only a group of identical genera in characteristic association, but also species in part identical with those later reproduced in the "Upper Carboniferous," the flora being largely composed of fern genera nowhere else known in pre-Carboniferous beds and devoid of all the Devonian and Silurian types supposed to be contemporaneous, is certainly going to the extreme in the doctrine of parallelism in development.

To return to Dr. Matthews's paper: The discussion of the "fern ledges" floras and their ages is supplementary to the announcement of the discovery, in beds correlated by Dr. Matthews with the No. 1 (Medina) division of the Mascarene series, at Beaver Harbor, New Brunswick, of an Arthrostigma flora. Arthrostigma has been regarded as characteristic of the Devonian. We shall therefore look forward with keen interest to the full publication with, let us hope, adequate illustration of this older flora. The new flora which is from a different region is said to have nothing in common with the "fern-ledges" floras, which include such common Carboniferous genera as *Calamites, Annularia. Astero-*

phyllites, Neuropteris, Alethopteris, Megalopteris, Pecopteris, Whittleseya and *Sigillaria*.

DAVID WHITE

PROFESSOR PUNNETT'S ERROR

IN Professor Punnett's admirable little book, entitled "Mendelism," there occurs an error of definition that ought not to go unnoticed. This error, which runs through the whole book, begins on page 2, where may be found this statement: "Among animals the female contributes the ovum and the male the spermatozoon; among plants the corresponding cells are the ovules and pollen grains."

The last half of the quoted sentence contains three distinct errors: (1) Half of the plant kingdom possesses no pollen grains nor ovules, yet its members have parts that correspond with the ova and spermatozoa of animals; (2) the ovules and pollen grains are not *cells* but each is a cell complex; (3) it is a gross mistake to regard the pollen grains and ovules of plants as corresponding with the spermatozoa and ova of animals.

The first two mistakes might be passed over; but the third, in a book that is written for the reading public, is unfortunate and should be corrected in the next edition. The pollen grain is multicellular and the ovule is multicellular. The genetic cells of higher plants are produced in these bodies. It is as correct to call the testis of an animal a gamete as to call a pollen grain a gamete. The terminology of the genetic cells in plants need offer no difficulty to the zoologist. If he will consult the literature, or his botanical friends, he will find that, besides using the term *gamete* for the conjugating cells of both plants and animals, he may use *ovum* and *spermatozoon* for plants as well as for animals.

F. C. NEWCOMBE

PHENOMENA OF FORKED LIGHTNING

As pointed out in a recent paper in SCIENCE, September 1, the negative end of a lightning discharge is forked. When visible we call it forked lightning. When such a system of drainage channels penetrates a shower of negatively charged drops, great differences in potential between drops not far removed from each other must be created. Before the flash the drops have approximately equal potentials. They then repel each other. Drops having radii of one mm. only need to be charged to a potential of 0.0031 volt in order that their repulsion for each other may balance their gravitational attraction.

As soon as the flash occurs these drops attract each other. They coalesce, and a brief dash of large drops of rain follows.

FRANCIS E. NIPHER

SCIENTIFIC BOOKS

A Study of Chiriquian Antiquities. By GEORGE GRANT MACCURDY. Memoirs of the Connecticut Academy of Arts and Sciences, Vol. III., March, 1911. New Haven, Conn. Pp. 249, 384 text figures, 49 plates.

In a beautiful volume Dr. MacCurdy has given us the fruits of a long and patient investigation of the excellent collection of antiquities from Chiriqui in the Museum of Yale University. Not too much praise can be given to the painstaking examination and clear description of the long series of specimens, to the careful grouping of the material, which makes it possible for the student to master the wealth of new material with comparative ease. The author's description is about the same as that given by Holmes, but with a few modifications in terminology and grouping. Together with Professor Putnam's paper on conventionalism in ancient American art, and Professor Holmes's earlier description of ancient art of the province of Chiriqui, we have here material that needs only the additional researches of the field investigator to give us a clear picture of the archeology of a part of the Isthmian region. It is fortunate that, for a comparison of cultural types, the archeologist has at his disposal the two careful investigations by Dr. Hartman on the eastern and western parts of Costa Rica.

The illustrations in Dr. MacCurdy's volume are of the excellence of all the work of Mr. Rudolf Weber, whose illustrations of the publications of the Heye Expedition and for-

merly of the publications of the American Museum of Natural History have won him well-merited recognition on the part of the students of anthropology.

The author treats in detail work in stone, pottery and work in metals. The principal part of the work is devoted to a discussion of pottery forms and decoration, and the work must be considered an important contribution to the study of decorative art. I think in this lies its greatest interest.

Although the author does not commit himself quite definitely in regard to any theory of the development of art, his inclination, as exhibited in the detailed discussion of specimens, is clearly to consider geometrical ornament as developed by conventionalization of realistic motives, and he seems to consider this process as occurring by an inner necessity. "If the line of art development were plotted, it would probably be found to rise rather suddenly to the acme of realism, and then drop slowly to about its original level. The accompanying series of illustrations, however, does not begin at the beginning, but rather at the crest of the realistic wave, and descends gradually to the trough, probably that one lying on the conventional side; yet some of the stages shown might just as well be steps in the ascending as in the descending scale. In other words, a definite chronological sequence has not yet been established" (p. 57). Still in the next sentence the author states that there are reasons for considering realistic animal forms as preceding conventionalized forms, but I have not been able to find these reasons. Only in the case of the transformation of simple forms of objects into life forms does he admit the inverse process. "We have now followed the various steps in the development of the complete zoomorphic unit from the commonplace mealing stone" (p. 30). "It did not require a wide stretch of the imagination to arrive at the zoomorphic possibilities of the plain tripod leg. By the application of nodes and pellets of clay to the hollow tripod supports they immediately assume animal forms" (p. 51).

The difficulty in proving or disproving these theories lies in the fact that the material studied is not dated, that we do not know whether some forms are older than others, or whether all belong to the same time. That changes of artistic style have occurred in these areas is more than likely, notwithstanding the meagerness of proofs of cultural sequences on our continent. Dr. Spinden's demonstration of changes in the technique of an art style in Central America, the analogous phenomena observed among the cruder civilizations of the northwest coast, are important from this point of view which should receive the closest attention of archeologists.

It seems to the mind of the writer that the chief objections to the attempted interpretation of the development of an artistic style from a study of the undated object alone lie in the formal character of the treatment of the problem. Dr. MacCurdy, like his predecessors, has given us a careful classification of form and ornament, arranged according to considerations of technique, and of greater or less complexity of form. Among these he selects the forms which seem most plausible as the starting point of the series and the rest are then arranged in order, a time sequence being substituted for a series based on similarities of form. It may be that the investigator happens to strike the correct arrangement, but, considering the complexity of the problem and the possibilities of development in various directions, the probability of having reached a true historical explanation is not very great.

Dr. MacCurdy sums up the series of processes that lead to conventionalization as due to reduplication, exaggeration, elimination or fusion of parts of units; transposition, shifting and substitution; isolation of parts and their use independently of the whole; wholesale reduction and simplification; adaptation to fit a given space (pp. 127, 229). All these may occur, but they do not prove a historical development, because they are merely an enunciation of the principles of classification or seriation chosen by the student.

Wilhelm Wundt, in his Völkerpsychologie,

has pointed out that in our studies of development of art the psychological processes of the artist are the essentials for a clear understanding of the history of art, and I think this point of view must be kept in mind constantly if we desire to understand the history of art development.

For this reason it seems to me that the purely classificatory method, as followed by Dr. MacCurdy as well as by previous students, is not likely to give us the desired clue. Neither can it be found in ethnological inquiry and the most copious explanatory notes, which must always be open to the suspicion of having been read into the designs by the natives.

We have to bring before our minds more clearly the procedure of the native artist, the conditions under which he works and the extent of his originality. The term conventionalization, which we so readily employ, should be taken in a stricter sense, and we must understand what happens in the mind of the artist—including under this term unconscious processes—who either conventionalizes a realistic representation or develops a realistic form out of a geometrical form. Thus the problem presents itself of discovering the fundamental art forms that exert a domineering influence over the artist.

From this point of view, it seems to my mind that the first element to be determined is what is stable in each art form. Dr. MacCurdy does this in his careful classification of the material; and the association between lack of painting and presence of attached decorative elements modeled in the round,—a conclusion which I think has quite a general validity;—the presence of painting and lack of relief decoration; and other more detailed characteristics of certain forms, like the presence of the rim in vessels with neck decoration are brought out clearly.

The next step in the discussion of the ware with attached ornaments, however, does not seem to me well taken. Dr. MacCurdy points out the great frequency of armadillo-like forms, and the peculiar character of carapace, foot, eye and tail ornaments. From these he concludes, if I understand him rightly, that the life motive is older than the elements just described, which are derived from it. The relationship of the ware with relief decoration to analogous types of neighboring districts does not seem to me to favor this view. It is the essential characteristic of all this ware, that the decorative elements consist of small nodes or fillets which are applied to the surface of the vessel or to some of its parts, like feet, neck, shoulder or handle; and which are decorated by a series of short parallel impressions. An oval node with single medial lines is often used to indicate an eye; a similar nodule with a number of parallel lines indicates the foot, a series of parallel, short fillets with parallel short crosslines, are applied to the bodies of animal forms, but also to the bodies of vases. Hartman[1] describes analogous technical motives from Chircot and Orosi in Costa Rica (for instance Pl. 22, Fig. 2; Pl. 27, Fig. 2; Pl. 37, Figs. 5, 6; Pl. 39, Fig. 1; Pl. 51, Fig. 8; Pl. 64, Fig. 7) which in technical character are so much like the Chiriqui specimens that we can hardly doubt that they are derived from the same device. It might seem that this method of decoration is so easily discovered that little weight can be attached to it. Its extended use in South and Central America and in the West Indies[2] is, however, quite characteristic of that area. In North America it is not common, except in the Gulf region.[3] In contrast with its frequency in the highly developed pottery of Central America its almost complete absence may be noted in Africa, where highly decorated pottery forms are by no means absent, and where lids with animal figures might seem to suggest readily

[1] C. V. Hartman, "Archeological Researches in Costa Rica," Stockholm, 1901.

[2] See, for instance, W. J. Fewkes, "The Aborigines of Porto Rico," 25th Annual Rep. Bur. of Amer. Ethnology, Fig. 36, p. 185; Pl. 76, Fig. *c;* Pl. 78; Pl. 79.

[3] G. P. Thruston, "The Antiquities of Tennessee," p. 146; Pl. 7; W. H. Holmes, "Aboriginal Pottery of the Eastern United States"; for references see index under "fillets" and "nodes."

the application of the device.[4] This is true also of the prehistoric pottery of Europe. Only in the slip (barbotine) decorations of the terra sigillata do we find anything resembling the American appliqué ornamentation, but since the material is applied in a semifluid state, it does not attain the same freedom of treatment. Nodes that do occur in European prehistoric pottery seem to have been made rather in imitation of punched bronze decorations and belong to a late period. Attached animal figures, made in clay, like those found at Oedenburg, also seem to be imitations of metal work and have never reached that development which is so characteristic of Central American ceramic art.[5]

The characteristic slit rattle feet of Chiriqui pottery prove even more conclusively than the application of fillets and nodes, that the art forms of this province must be considered as a special development of forms characteristic of a much wider area. This type of foot is so well known that no special reference to its occurrences outside of the Chiriqui territory need be given.

We are thus led to the conclusion that the armadillo motive of the author is historically related to the method of decorating and building up vessels from separate pieces, nodes and fillets, the nodes and fillets being in many regions decorated by parallel incised lines, or by dots. If this is true, the armadillo motive can only be a specialized application of the building up of animal motives from the elements in question, and neither can the elements themselves be considered primarily as symbols of the armadillo (p. 61), nor can all the animals built up of these elements be interpreted as armadillos.

[4] "Notes analytiques sur les collections ethnographiques du Musée du Congo," Vol. II., "Les industries indigènes"; Part 1, "La céramique." (Fig. 293 *a* is the only one that may exhibit this technique.)

[5] Relief ornaments consisting of fillets have been described from northern Germany, Bohemia, Bosnia and Italy. See, for instance, Radinsky, Butmir, Vienna, 1895; K. Koenen, Gefässkunde, Bonn, 1895, Pl. III., Fig. 12.

For the same reason I am inclined to doubt the correctness of the interpretation of the alligator group, which was first given by Professor Holmes in the work before referred to. The upturned snout, of which much is made as a means of identification, is a character of much wider distribution than the alligator motive. The monkeys on Plates 27 and 32*a* of Dr. MacCurdy's book have it, and we find it as well in the interior of Costa Rica[6] as in parts of South America. This is no less true of the curious "nuchal appendage" which occurs in Costa Rica[7] as well as in South America,[8] and of the dotted triangle.

It seems to me that the essential point of this consideration lies in the technical and formal motives that are common to a large area, although differing in details in its provinces. These are the materials with which the artist operates and they determine the particular form which a geometrical motive or a life motive takes. If the notched fillet and node are the material with which the hand and the mind of the artist operate, they will occur in all his representations. If the conventional outline of the animal body has a definite form, all animals will tend to be represented in that manner. I have tried to emphasize at a previous time[9] the importance of such fixed traditional forms in determining the conventional style of decorations.

In his further descriptions of the art work of Chiriqui Dr. MacCurdy notes the similarity of motives used in metal castings, notably

[6] Hartman, *l. c.*, Fig. 2, Pl. 35, Pl. 81, Fig. 286, p. 128. The region in question has more frequently a proboscis-like appendage, rolled downward.

[7] Hartman, *l. c.*, Fig. 2; Pl. 35.

[8] M. H. Saville, "Contributions to South American Archeology." The George G. Heye Expedition. "The Antiquities of Manabi, Ecuador," Pl. 8. See also E. Seler, "Archäologische Untersuchungen in Costarica," *Globus*, Vol. 85, 1904, p. 237.

[9] Notes to G. T. Emmons, "The Chilcat Blanket," *Memoirs of the American Museum of Natural History*, Vol. III., Part 4, pp. 355 et seq.

in the gold castings, and the armadillo pottery, a similarity which consists essentially in the use of detached figures, nodes and fillets, as described before. He also calls attention to the frequent occurrence of the head with upturned snout—the alligator-head design of painted pottery—in this technique, a feature that had escaped the attention of previous students. At least one of them has, however, the type of proboscis rolled down (Pl. 58, Fig. *g*) which is so common on the plateaus of Costa Rica. In this case also the rigidity of the fundamental form seems particularly suggestive to the writer, because a variety of animals have all been presented in analogous outlines.

FRANZ BOAS

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Principles of Chemical Geology. A review of the Application of the Equilibrium Theory to Geological Problems. By JAMES VINCENT ELSDEN, D.Sc. (London), F.G.S. London and New York, Whittaker and Co. 1911. 222 pages, with 44 figures.

While an imaginative geological writer has recently asserted that "to be more productive than it is, geology must become more speculative," it is gratifying to note the steady advance that is being made in the explanation of geological phenomena along the lines of established principles in the fundamental sciences of physics and chemistry. With the rapid development of physical chemistry there has been a corresponding improvement in conceptions regarding processes that have taken part in the production of the earth as we know it. And every effort that is made to place these fundamental concepts within the reach of students of geology, and which succeeds as well as the book before us, should be welcomed as a contribution of the first order to the advancement of the science.

But it must be borne in mind that any developing branch of human knowledge is an assemblage of observations and conclusions of variable degrees of accuracy and truthfulness, subject to constant revision and readjustment. And in the problem of the application of principles of physics and chemistry to the phenomena of the earth, as a whole, and in detail, these are the variable factors of divergent opinion regarding the laws to be applied, and the still very inadequate data relating to the phenomena to be explained, as well as an accumulation of conflicting observations and of conclusions, in some instances misleading or actually incorrect. Moreover the multitudinous requirements in each branch of learning prevent the worker generally from acquiring independent judgment in more than one distinct branch of science.

For these reasons each contribution to the solution of the highly complex problems to be found in the study of rocks and minerals must have its particular characteristics arising from the point of view and range of experience of its author, as well as from the source of his information and the quality of his judgment.

In the contribution made by Mr. Elsden there appears to be the experience of a physicist familiar with the subject of physical chemistry, and capable of presenting the essential principles in a clear and simple manner, not wholly free, however, from the technology of the science. There is less of the chemical side of the subject than the title of the book suggests, which might better have been "Principles of Physical Chemistry Applied to Geology," for there are phases of the chemistry of the earth not touched upon. The application of the principles discussed is well made in most cases, and the examples that may illustrate them are happily chosen from the mass of recorded observations to be found in the literature of geology and petrology. In the selection and rejection of conflicting opinions in certain instances the author's judgment has been on the side of the more probable—according to the opinion of the reviewer. But the author does not appear to possess personal knowledge of the petrographical and mineralogical data appealed to in illustration of particular principles.

The author states that one of the main objects he has had in view is to show that the

key to the solution of the problems in the physical chemistry of geology lies in the determination of the conditions of equilibrium of each set of actions, or states of existence, of the factors under discussion; and further that he has attempted rather to stimulate interest in this branch of geology than to provide a complete exposition of the subject. It appears that this attempt is eminently successful, and that students of geology and petrology will be greatly benefited by this presentation of the principles in question.

The book consists of 10 chapters dealing with (1) Equilibrium between the Crystalline and Amorphous States; (2) Equilibrium as Influenced by Viscosity; (3) Diffusion as a Factor of Equilibrium; (4) Surface Tension as a Factor of Equilibrium; (5) Vapor Pressure as a Factor of Equilibrium; (6) Equilibrium Conditions of Polymorphous Forms; (7) Equilibrium in Solutions; (8) The Eutectic Theory; (9) The Theory of Solid Solutions Applied to Geological Problems; (10) On the Conditions of Chemical Equilibrium in Geology.

Without undertaking to give a synopsis of the contents of these chapters, or to do more than express approval of the method of treatment with a recommendation that they be carefully studied by those interested in the subject, attention may be called to several instances in which the fallibility of the literature relied upon by the author may be illustrated, or to instances where it has been misinterpreted. In the Chapter on Viscosity the observation of Barus on the combination of water and glass at temperatures between 185° and 200° C. is cited, and the impression is given that it is an operation of unlimited applicability to all glasses. Whereas Barus subsequently found that other commercial glass did not combine with water under any conditions which his apparatus was able to impose. The general conclusion stated by Mr. Elsden as to the effect of water in solution in silicate magmas in reducing viscosity is, nevertheless, correct, as other observations have shown.

In connection with surface tension and its explanation of the growth of larger crystals at the expense of smaller ones the author has confused his citations by referring to a description of the obsidian at Obsidian Cliff, Y. N. P., by the reviewer, as containing a supposed application of the principle to the weathering of the laminated rock. There is no reference to weathering in the paper mentioned, and its author never entertained any such ideas as those implied in the comment by Mr. Elsden.

In the discussion of crystallizations in metastable and labile states of solution it is quite evident that the author is not relying on his own knowledge of rocks, but has been misled by the dogma of "first and second generations of crystals," when he states that "while the metastable state persists small crystals could not be produced," for nothing is commoner than seriate porphyritic fabric in igneous rocks, and the presence of various sized crystals of the same kind of mineral. His treatment of the subject of crystallization is not so satisfactory as that of other portions of his subject. And in the discussion of the amphibole and pyroxene series the lack of appreciation of the chemical phase of the problem is apparent.

Aside from these criticisms the book is a valuable contribution to the literature of geology, and should be studied by all who desire to understand the bearing of physical chemistry on the problem of the formation and alteration of minerals and rocks.

J. P. IDDINGS

THE RELATION BETWEEN THE COLORATION AND THE BATHYMETRICAL DISTRIBUTION OF THE CYCLOGASTERIDÆ

IN a recent article in SCIENCE[1] Dr. H. B. Bigelow gives a résumé of a preliminary report[2] by Dr. Johan Hjort on the results of the

[1] July 7, 1911.

[2] *Geographical Journal*, Vol. 37, 1911, pp. 349–377, 500–523. Not seen by the writer.

Michael Sars North Atlantic expedition in 1910. Dr. Bigelow cites, as one of the important results of the expedition, the experiments undertaken to discover the depth to which sunlight penetrates below the surface of the ocean and the relation between this and the bathymetrical distribution of animals exhibiting certain types of coloration. Dr. Hjort found that the red rays are absent and the blue and violet rays present at 500 meters; at 1,000 meters ultra-violet rays are perceptible and at 1,700 meters no trace of light could be detected. The black fishes and red prawns taken in the daytime in temperate latitudes were from a depth of 500 meters or more, *i. e.*, below the penetration of the red light rays. In more northern latitudes these animals were taken nearer the surface. In these regions the red light rays probably do not penetrate so far below the surface. Above the 500-meter level the fishes were found to be "characterized by lateral compression, larger and often telescopic eyes, light organs and silvery sides." These facts led Dr. Hjort to suggest that the lower margin of the area penetrated by red light rays marks the border between two differently colored faunas. Dr. Bigelow, in support of this view, states that the *Medusæ* apparently can be divided into two color groups which overlap at 250 to 300 fathoms. The species above this level are characterized by little pigment and iridescence, and those below by red and brown pigment.

The same relation between the vertical distribution and the coloration was found to exist in the young. The young of some of the species spend their larval existence near the surface and do not exhibit the adult coloration, this being acquired as they increase in size and descend to the habitat of the adult. The young of other species develop in the same region in which the adults are found and acquire the adult coloration much earlier. The coloration and vertical occurrence are correlated from the earliest stages.

The writer, during the preparation of a monograph of the Cyclogasteridæ, has had occasion to trace out the correlation between the coloration and the bathymetric distribution of these fishes. The results obtained are of interest in connection with those obtained by Dr. Hjort and Dr. Bigelow and it seems opportune to present a general account of them in advance of the main body of the work.

In reviewing the results presented here it should be borne in mind that the records upon which they are based are very incomplete when compared with those available to Dr. Hjort. It should also be noted that Dr. Hjort's conclusions result from the study of the general fauna while those of the writer are based upon the examination of a single family. This may account for the difference in the conclusions arrived at. The methods employed by the *Albatross* are very unsatisfactory for the solution of problems dealing with vertical distribution. The dredge is sent down and hauled up open, catching forms through all the intervening depths. Unless the animals captured have some peculiarity of structure which indicates their habitat as being on the bottom it is impossible to decide at what depth they entered the dredge. The intermediate hauls are made at a depth of 300 fathoms and the net hauled up open. The absence of species from the intermediate hauls indicates that their habitat is below this depth, but how far below remains a mystery. Also records of the coloration of the fishes, as they first appear, are very seldom taken. The colors frequently change in spirits. The translucent reddish cyclogasterids usually become an opaque white. This restricts the conclusion that can be drawn from the study of such specimens.

The Cyclogasteridæ is a favorable group in which to work out the modifications of structure and color as the species become adapted to the deep sea. This is true because the family is abundantly represented at all depths from the tide pools down to 1,973 fathoms. About 42 species are known to inhabit depths of less than 100 fathoms, 49 inhabit the region between 100 and 500 fathoms and 34 the depths greater than 500 fathoms. Starting with the tide-pool species as the most primitive, we can readily trace out definite modifi-

cations of form, structure and color as the species became more and more modified by the environment of the deep sea. We will confine our attention to the modification of the coloration and the relation between this and the distribution of the species.

The Cyclogasteridæ consist of about 100 species. The majority of these are placed in three large genera. The genus *Cyclogaster* consists of about 30, *Careproctus* of 38 and *Paraliparis* of 21 species. The remaining genera are monotypic or consist of a few species. The vertical distribution and the coloration of the three large genera will be described first. This will be followed by a chart indicating the distribution and coloration of all the species of the family.

Before entering upon a discussion of the genera it is advisable to review briefly the factors which lend color to the different environments inhabited by these fishes. For our purpose the color of a tide-pool environment may be said to be due to three factors or groups of factors. These are: (1) sunlight, (2) organisms and their remains, (3) inorganic materials of which the bottom is composed. In the tide-pools the coloration of the second factor may appear to depend upon the other two factors. In the oceanic depths below the penetration of light and far above the bottom these two factors are absent. The color of the organic life, if protective, can not be dependent upon their influence. It is necessary to assume the presence of light other than sunlight. We know that there is such light as can be produced by light organs. It has been suggested that there is another source of light on the bottom of the ocean. The decomposing animal matter may give off a phosphorescent glow of such intensity that the large-eyed fishes may be able to detect objects.

The modification of the color factors of the environment is accompanied by a modification of the coloration of the fishes. The sunlight is more intense and the organic life more brilliantly colored in the tide-pools and shallow waters of the tropics than in the arctic regions. The difference in the intensity of the sunlight is accompanied by a difference in temperature, but we shall ignore all the factors which compose an environment except those that exhibit color. As we descend below the surface of the ocean the sunlight becomes less intense. The organic life becomes less brilliantly colored. The red light rays probably do not penetrate below 500 meters or 273 fathoms. It has been suggested that this depth marks the border between two differently colored faunas. Dr. Hjort found that the fishes above this depth are characterized by silvery sides and those below by black pigment. The black forms are found nearer the surface in northern latitudes. Where the 273-fathom level touches bottom and where it is far above bottom constitute two differently colored environments. If at this level the color of the bottom has an influence, then the color of the fishes inhabiting these two environments should be different. It will be shown on the following pages that the bottom-inhabiting species of cyclogasterids appear to be differently colored from the free-swimming forms. There is a certain depth in the ocean below which light fails to penetrate. This will be less in the arctic than in the torrid regions. Its importance in marking the region between two faunas remains to be carefully worked out.

Cyclogaster is a shallow water genus. The species are common in the tide-pools and shallow cold waters of the northern and southern hemispheres. At least 21 of the 30 species have been taken in less than 10 fathoms. Only 5 species have been taken from depths below 100 fathoms and 3 from below 200 fathoms. One specimen has been taken at 250 fathoms. It is thus seen that the genus is confined to the illuminated area of the oceanic waters. We may provisionally place the lower margin of the bathymetric distribution of the genus at the level at which Dr. Hjort found the red light rays absent, the 500-meter or 273-fathom level.

The species of the genus, with but three exceptions, have a similar type of coloration. The colors harmonize with those of the other shallow-water fishes of northern regions. The

species typically have a variegated coloration which consists of bars, blotches, lines and mottlings of white, slate, brown and black, the predominating colors of the fishes of northern regions.

The coloration of the deeper-water species is slightly modified by the environment. The variegated coloration is retained, but in addition to this, in two or three species, a reddish lining to the dermis and a silvery or a black peritoneum have been acquired. These are the colors predominating in the genus *Careproctus* which flourishes in regions between 100 and 500 fathoms. The vertical distribution of each species is important in considering its coloration. Species such as *Cyclogaster dennyi* and *Cyclogaster fucensis,* which extend from within 2 or 3 fathoms of the surface down to 123 and 212 fathoms, do not show an appreciable change in coloration.

Careproctus is the most interesting genus in the family. It has been derived from the shallow-water genus *Cyclogaster* and presents the first distinct modification of structure and color caused by the environment of the deep sea. It has given rise, directly or indirectly, to practically all of the other deep-sea genera. The distribution of the species extends from shallow water to great depths, or from 29 to 1,823 fathoms. The genus seems to flourish best in the region between 100 and 500 fathoms. Two thirds of the species are found in this region.

The coloration of species of *Careproctus* is very distinct from that typical of the species of *Cyclogaster.* None of the species are variegated. The nearest approach to this condition is that of *Careproctus cyclospilus* and *Careproctus mirabilis,* two shallow-water species, which have pink blotches over the body. The species are typically translucent, reddish translucent and black. In a number of species the posterior part of the body only is black. It appears that the black pigment encroaches upon the body from the caudal region anteriorly.

The species of *Careproctus* can be arranged in three color groups. These groups include the light-colored species, the black species and the species intermediate between these two. The light-colored group includes the translucent, whitish and reddish species. When placed in alcohol the translucent and reddish appearance is usually lost and the species become an opaque milky white. It is doubtful if any of the species are this color in life. In the black-colored group are included all the black species. In the third group are included those species which are dusky or have the posterior part of the body, the gill cavity, peritoneum or stomach black. The distribution of these three color groups will be considered separately.

The light-colored group, consisting of 27 of the 38 species of the genus, is represented in depths between 29 and 1,046 fathoms. The majority of these species are found between 100 and 500 fathoms. Six species are found in less than 100 fathoms and 4 below 500 fathoms. The distribution of the light-colored species apparently has no more relation to the 273-fathom level than to the 400-fathom level. Eighteen species are found above the 273-fathom level, 13 below it and 4 on both sides, while 22 species are found above the 400-fathom level, 10 below it and 5 on both sides.

The distribution of the remaining two groups of species does not indicate that the 273-fathom level marks the border between two differently colored faunas. The dusky species, of which there are 8, are found between 35 and 887 fathoms, but the majority have been taken between 300 to 500 fathoms. There are 3 species in the black group and these are all from below 405 fathoms.

The color of the peritoneum is of interest in connection with the color of the body and the distribution. The peritoneum is sometimes black when the epidermis is white, but apparently is never white or silvery when the epidermis is black. In preserved specimens it is sometimes difficult to decide whether the peritoneum was originally a dull white or silvery. It appears, however, that the silvery peritoneum is most common with the reddish translucent species. Dr. Hjort reports that the fish fauna above the 273-fathom level is characterized by silvery sides. A silvery

peritoneum in the translucent species of *Careproctus* gives these fishes somewhat the appearance of having silvery sides. The distribution of the species having a silvery peritoneum apparently is not influenced by the change in environment at the 273-fathom level.

The facts concerning the coloration and distribution of the species of *Careproctus* indicate that the 273-fathom level is of no greater, if of as great, importance than the 400-fathom level in marking the border between two differently colored faunas. The former level appears to be of little or no significance in the distribution of the light-colored species, while the latter level marks the upward limit of distribution for the black species and contains the largest number of species intermediate between white and black, *i. e.*, the dusky species.

The genus *Paraliparis* in structure, coloration and distribution is more of a deep-sea genus than *Careproctus*. The species of the genus may be placed in three color groups, but the proportion of the species in the groups differs from that in *Careproctus*. For instance only 8 per cent. of the species of *Careproctus* are black while 50 per cent. of the species of *Paraliparis* are of this color. All the species of *Paraliparis* have a dusky or black peritoneum. Only 25 per cent. of the species *Careproctus* have the peritoneum black. The species of *Paraliparis* typically inhabit greater depths than do the species of *Careproctus*. The high and low levels of distribution for the two genera are almost identical, but what may be termed the centers of population of the two genera differ. Half of the species of *Careproctus* are taken above and half below the 300-fathom level. The 500-fathom level holds the same relation to the distribution of the species of *Paraliparis*. We thus see that there is a difference of 200 fathoms between the centers of population of the two genera. There must be considerable difference in the amount of light present at these two centers of population. With this difference in the amount of light is associated the difference in the number of black forms in the two genera.

The relation between the coloration and the distribution of the species of *Paraliparis* is the same as in *Careproctus*. Without entering into much detail we will state that the 273-fathom level is of no significance in the distribution of the light-colored species. Only two of these species have been taken below this level. The distribution of the black species is interesting because, as in *Careproctus*, it extends from 400 fathoms downward.

The distribution of all the species of the family reinforces the conclusions that may be drawn from a study of the distribution of the species of the genus *Careproctus*. The chart indicates the coloration and distribution of all the species. It can be seen that the 273-fathom level marks the lower limit of distribution for the variegated species, but is of no significance in regard to the distribution of the light-colored, dusky or black species. The region at about 400 fathoms is of more importance. It marks the depth at which the light-colored species are reduced in numbers, and where the dusky species are the most common. It also marks the upper limit of distribution of the black species.

Depth	30	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000
Variegated	23	11	4	3																	
Light	1	7	10	15	12	11	4	4	1			1									
Dusky		2	8	7	11	11	7	6	3	2	2	1	1	1	1	1	2				1
Black						3	2	3	1	2	3	3	1	1	1	1	2	1	3	3	

Chart illustrating the coloration and bathymetrical distribution of the Cyclogasteridæ. Species ranging through depths represented by several sections are counted in each section.

The facts just stated indicate that, in general, the coloration of the species of *Cyclogasteridæ* depend upon their bathymetrical

distribution. The question naturally arises: are these fishes protectively colored, or, is the color dependent upon the modification of structure or some other factor besides the color of the environment? The question is complex, because there is a parallel modification of color and structure due to the environment of the deep sea. It frequently happens that a certain type of structure is associated with a certain type of coloration. Also the coloration of the species sometimes appears to be independent of either the color of the environment or the type of structure. Those biologists who view with suspicion the attempts to explain the coloration of tide-pool fishes by means of the protective coloration theory will be even more skeptical toward any effort to explain the coloration of deep-sea fishes by means of the same theory. The factors of a tide-pool environment are spread out before us but those of the deep-sea are hidden. We do not know that there is sufficient light in the greater depths of the ocean to enable the fishes to see and of course without light there can be no protective coloration. If this is a region of total darkness the color of an animal can not be an aid to its concealment. So far as protection is concerned a fish may just as well be brilliantly colored as transparent or black. But they are not brilliantly colored. Instead they are typically of a uniform coloration, which is usually black. In the regions of dim light they are of another color. The coloration bears some relation to the depth at which the species exist. The amount of sunlight depends upon the depth and consequently the coloration appears to depend upon the amount of sunlight to which the species are subjected. There are two possible sources of light in the oceanic depths below the penetration of sunlight. We know that certain animals of this region have light-producing organs and the decomposing animal matter may give forth a phosphorescent glow. And, as if for the purpose of sight in a dim light, the eyes of the fishes have become greatly enlarged. Regardless of the merits of the protective coloration theory it furnishes us with a fascinating field for speculating. The attempt to explain some of the facts concerning the coloration of the Cyclogasteridæ by the protective coloration theory will not be amiss here.

The environment of the deep sea has had a different effect than the dark cave environment upon fish life. Dr. Eigenmann has made an exhaustive study of cave fishes. In these fishes the eyes atrophy and the pigment is reduced or absent. Dr. Eigenmann believes that we have here an example of the inheritance of an acquired characteristic. The case, as he so ably presents it, appears unassailable. The color of some of the cave fishes can not be protective, for there are no enemies to protect them from. The fishes of the deep sea are surrounded by other fishes with large eyes and long teeth. The presence of a light would allow the struggle for existence to become more intense. The effects of a cave environment and the deep-sea environment upon the coloration of fishes are similar up to a certain point and then widely diverge. The effects of the dimly lighted cave and the dimly lighted regions of the ocean lead to the reduction of pigment. The effect of a totally dark cave is to allow the fishes to lose all their pigment. In contrast to this the fishes in the ocean below the penetration of sunlight acquire pigment and become wholly black. Possibly the difference in the effects of the two environments can be explained by the protective coloration theory, which can not explain the coloration of cave animals but may explain the coloration of deep-sea animals.

The overlapping of faunas calls for further discussion if we are to consider the fishes as protectively colored. The genus *Careproctus* originated in moderately deep waters. From this region representatives of the genus migrated into shallower waters and down to great depths. Those that entered shallower waters retained their light and uniform coloration. Of those that descended to greater depths some retained their original coloration, but the majority became black. The species that entered shallow water became associated with the variegated species of *Cyclogaster*. The distribution of these two genera overlap be-

tween 29 and 250 fathoms. The association of species of the two genera may be more apparent than real, for the species of *Cyclogaster* are typically bottom-inhabiting forms and those of *Careproctus* free-swimming. The distribution of the light-colored and black forms overlap between 400 and 1,000 fathoms. The gradual merging of one environment into another and the force of heredity may account for the overlapping of the faunas, but, as is the case with the shallow-water species, the differently colored ones may not intermingle. Let us imagine a portion of the ocean bottom as illuminated by a lantern. A black fish on a dark bottom or near the margin of the illuminated area would be practically invisible. A transparent or a reddish translucent fish would be little more discernible. Away from the bottom and near the source of light a black fish would be more conspicuous than the others. At such depths it is difficult to decide which species rest upon the bottom and which swim freely some distance above it. The deep-sea Cyclogasterids, which, from their structure, we assume to be free-swimming, are nearly all light-colored. Nearly all of those which appear to live upon the bottom are black. It should be noted that among other deep-sea fishes a number of free-swimming species are black and also that some of the bottom-inhabiting species may be light-colored. It can be seen from the above discussion that the light-colored species in the depths below the penetration of sunlight may be as protectively colored as the black forms. The disparity in the numbers of light-colored and black species suggests that this is not true or that the majority of the species live upon or very close to the bottom.

The significance of the predominance of reddish color in the light-colored species is unknown. This type of coloration may be considered as being intermediate between the translucent and black types and having the partial advantages of both. In dealing with this question the color perception of the eyes of fishes should be taken into consideration. If the eyes of fishes lack the color perception of our own and are simply camera eyes the reddish species will appear gray and be inconspicuous in their environment.

We have intimated that, in addition to a change in coloration, the deep-water species become translucent. The tide-pool species are soft and flabby and no great change is required for them to assume a translucent jelly-like appearance.

In concluding I wish to express my appreciation of the work of the *Michael Sars* in 1910. The observation made on this expedition that the coloration and bathymetrical distribution of the young fishes are correlated from the earliest stages is confirmed by my work on the Cyclogasteridæ. The young of these fishes inhabit the same regions as the adults and are similarly colored. Dr. Hjort's suggestion that the 500-meter or 273-fathom level marks the border between two differently colored faunas does not harmonize with the conclusions I have reached from a study of the Cyclogasteridæ. The acquisition of more carefully taken records of these fishes resulting from expeditions as carefully planned as that of the *Michael Sars* may cause us to modify our conclusions concerning the importance of the 273-fathom level in relation to the distribution and coloration of the Cyclogasteridæ and bring them more in accord with those of Dr. Hjort.

Charles Victor Burke

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SPECIAL ARTICLES

ISOSTASY, OCEANIC PRECIPITATION AND THE FORMATION OF MOUNTAIN SYSTEMS

The theory of isostasy postulates the uniformity of the weight of the earth's crust over the surface of the earth. It was suggested by Major Sutton[1] in 1889. It has recently received considerable attention by geodesists and geologists and has received quantitative confirmation by the researches of Hayford.[2] Recent work has been along the line of investigating the effect of displacement by erosion and the resulting equilibrium flow.

[1] *Bull. Phil. Soc. Washington*, 11: 51–64, 1889.

[2] See Science, February 10, 1911; also H. F. Reid, *Proc. Am. Phil. Soc.*, 50: 444–451, 1911.

No one appears to have considered the effect of oceanic precipitation in the middle geologic ages.

It is sufficient for this discussion to divide the earth's geologic history into three periods; the fluid age, the crust-steam age, and the crust-ocean age. During the crust-steam age the crust increased gradually from nothing at all to an effective thickness, including the layer of partial solidification, of several miles. During the larger part of this age, the water now forming the oceans was probably all in the atmosphere. The period of oceanic precipitation was probably quite extended on account of the heat liberated by condensation as well as the increased admission of solar radiation due to the clearing of the atmosphere.

At the time when liquid water began to exist in quantity, the cooling of the earth's crust had progressed far below the freezing-points of nearly all the materials of the crust, and the most plausible assumption is that the crust was of considerable thickness. It is also probable that the earth's surface was fairly level, the flatness depending upon the uniformity of distribution of rock materials of different densities.

Consider now the effect of superposing on this early crust a great quantity of material of low density, namely, the water of the oceans. Near the borders of the great oceans, we should then expect to find a severe outward thrust of crust comparable in mass to the mass of the ocean, but in volume less in inverse proportion to its density.

The isostatic conditions would further lead us to look for the accommodation to this displacement material farther inland, in a general continental elevation increasing toward and up to the border ranges.

This suggestion is put forward for what it may prove to be worth. Whatever may have been its consequences in detail, if the isostatic condition has been even approximately adhered to during the earth's history, the precipitation of the oceans must have had a profound effect on the elevation and depression of portions of the earth's crust. With more definite knowledge of the physical properties of geological materials it should be a mere mathematical problem to determine what those effects have been.

P. G. Nutting

Washington, D. C.,
September 12, 1911

MUSICAL ECHOES

The phenomenon of musical echoes has been known for a long time and has secured recognition in the text-books on sound. Thus we read:[1]

> Frequently, a sharp sound, such as the clapping of the hands or of two boards together, is reflected in a room or a corridor with smooth, parallel walls as a more or less musical sound. A similar effect is often observed when one is walking near palisading, each footstep of the observer being followed by a musical ring. The effect is only noted after some sudden sound, and may often be heard very distinctly on clapping the hands or on knocking two stones together.

The Greek Theater at the University of California presents a pronounced musical echo, the conditions being especially favorable to the production of the phenomenon. The seats are made up of a series of large concrete steps that are semicircular in shape and that rise regularly towards the back. If an observer generates a sharp sound in front of the stage at the center of the circles of steps the sound passes out symmetrically and strikes the steps in perpendicular planes and is reflected and diffracted back to the source of sound. The pulses of sound reflected from the successive steps follow each other regularly and thus set up a musical sound which is heard by the observer.

It occurred to the author that the pitch of the sound might be determined. The method of experiment was to generate a musical echo as already described and to compare the pitch of this sound with that of an adjustable turning fork. A check on the final result was found by calculating the pitch from the relation $n = v \div \lambda$ where n is the pitch of the sound, λ the wave-length and v the velocity of sound at the temperature of the theater. It is

[1] Poynting and Thomson, "Sound," pp. 31, 32.

to be noted that the wave-length is equal to *twice* the width of the steps (see Fig. 1). The advancing wave of sound xy strikes the first step and part of the wave is reflected. When xy reaches the second step, the sound from the first step has already traveled back a distance equal to the width of the steps. Therefore, the distance between the reflected pulses of sound—the wave-length—is equal to *twice* the width of the steps. It should be noted also that this phenomenon shows clearly the diffraction of sound. The fact that an observer can hear the separate pulses of sound at any point in front of the steps, indicates that the sound must spread out from each step as a center of disturbance.

The results of the observations follow. The observed pitch as determined by an adjustable Koenig fork was 226 vibrations a second. The pitch was calculated from the relation $n = v \div \lambda$ from the following data. The observed temperature was 22° C., hence the velocity of sound[3] was $v = 33{,}200 + 61 \times 22 = 34{,}542$ cm./sec. The width of the steps was 76 cm., hence $\lambda = 2 \times 76 = 152$ cm. Finally $n = 34{,}542 \div 152 = 227$ vibrations per second.

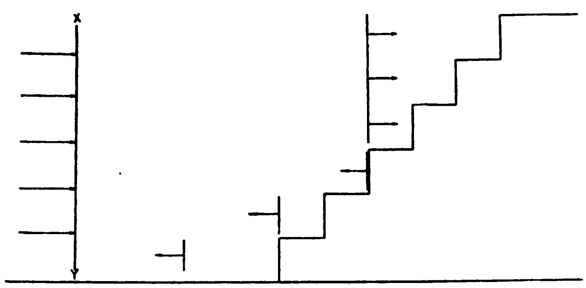

Fig. 1

The agreement between the observed and calculated values is closer than one would expect. The pitch of the fork was not corrected for temperature. Another source of error lies in the fact that the outgoing pulse of sound struck the steps at an angle rather than perpendicularly, so that the wave-length was somewhat greater than twice the width of the steps.

[3] Poynting and Thomson, "Sound," p. 21.

A second example of a musical echo was observed when a sharp sound was reflected from a set of bleachers on the athletic field at the University of Illinois. The pitch was determined, as in the former case, although the conditions were different and not so favorable. The bleachers were constructed of wood and were situated in a long straight row. If a rifle was shot off at some distance in front of the bleachers, an observer heard the reflected musical echo distinctly. The data taken follows. Temperature = 25° C., velocity of sound 34,725, width of steps = 73.5 cm., $n = 236$ vibrations per second. The pitch as observed by a tone variator was 235, although other observers nearer the bleachers obtained a value 241. The agreement between the calculated and observed pitches is as close as could be expected.

Aside from the novelty of the experiment, it is interesting to learn that the pitch of the echo is so definite. The notes given out in both cases cited is about a tone below middle C, hence where an observer expects a musical echo from steps about 30 inches wide, he can anticipate the result very nearly by first humming the expected tone.

F. R. Watson
University of Illinois,
May 17, 1911

SOCIETIES AND ACADEMIES

AMERICAN MATHEMATICAL SOCIETY

The eighteenth summer meeting of the American Mathematical Society was held at Vassar College on Tuesday and Wednesday, September 12–13, extending through two ses-

sions on Tuesday and a morning session on Wednesday. Thirty-two members were in attendance. Ex-presidents Thomas S. Fiske and Henry S. White occupied the chair in alternation. The council announced the election of the following persons to membership in the society: Professor Frederick Anderegg, Oberlin College; Dr. C. E. Brooks, Northwestern University; Mr. G. G. Brower, Cascadilla School; Mr. W. C. Graustein, Harvard University; Dr. Dunham Jackson, Harvard University; Mr. W. V. Lovitt, University of Washington; Mr. J. C. Raysworth, Washington University; Mr. L. L. Smail, University of Washington; Dr. E. B. Stouffer, University of Illinois; Dr. S. E. Urner, University of Wisconsin; Professor J. N. Van der Vries, University of Kansas; Mr. C. W. Webster, University of Washington. Twelve applications for membership in the society were received. The total membership is now 658.

Luncheon was served by the college on both days. On Tuesday evening twenty-nine members gathered at the usual informal dinner, at the close of which brief remarks were made by Professor Birkhoff on Moore's general analysis and by Professor A. G. Webster on wider views in mathematics and physics. Wednesday afternoon was devoted to an excursion to Lake Mohonk. At the close of the meeting the hospitality of Vassar College was recognized by a vote of thanks.

The following papers were read at the summer meeting:

Edmund Landau: "Ueber eine idealtheoretische Funktion."

W. A. Hurwitz: "On the pseudo-resolvent to the kernel of an integral equation."

W. A. Hurwitz: "On mixed linear integral equations."

Elizabeth R. Bennett: "Simply transitive primitive groups whose maximal subgroup contains a transitive constituent of order p^2 or pq, or a transitive constituent of degree 5."

Florian Cajori: "On a rare book of Michel Rolle and the history of 'Rolle's theorem.'"

L. C. Karpinski: "The Algebra of Abū Kāmil Shojā ben Aslam."

F. W. Beal: "Normal congruences determined by centers of geodesic curvature."

Arnold Emch: "On the congruence of rays realizing circular transformations between two planes."

Joseph Bowden: "The two fundamental relations of the calculus."

J. E. Rowe: "Covariant curves of the R^4 and R^5."

G. A. Miller: "A third generalization of the groups of the regular polyhedra."

G. A. Miller: "Some properties of the group of isomorphisms."

L. P. Eisenhart: "Minimal surfaces in plane four-space."

Arthur Ranum: "On the projective differential geometry of spreads generated by ∞^1 flats."

E. W. Castle: "A graduation of the combined experience table of mortality to Makeham's formula by the method of moments."

S. Lefschetz: "On the existence of loci with given singularities."

S. Lefschetz: "On some topological properties of plane curves."

Virgil Snyder: "Periodic quadratic transformations in a ternary field."

A. G. Webster: "On a new mixed boundary problem in connection with the telegrapher's equation."

A. G. Webster: "On the wave potential of a circular ring of sources."

A. G. Webster: "Solid viscosity versus elastic hysteresis in the transverse vibration of an elastic bar."

G. D. Birkhoff: "New proof of the theorem concerning matrices of analytic functions."

G. D. Birkhoff: "On the simplest type of irregular singular point."

G. A. Bliss: "A generalization of the preparation theorem for a power series in several variables."

Oswald Veblen: "On the definition of multiplication of irrational numbers."

H. T. Burgess: "One-parameter groups of contact transformations defined on a fixed quadric by a bilinear form."

Joseph Bowden: "Making a recitation schedule."

The next meeting of the society will be held at Columbia University on Saturday, October 28. The San Francisco Section will meet on the same day at the University of California.

F. N. Cole,
Secretary

SCIENCE

FRIDAY, OCTOBER 13, 1911

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

AMERICAN VETERINARY EDUCATION AND ITS PROBLEMS[1]

IN analyzing the subject assigned as my part of the committee's report, I became deeply impressed with the responsibility that rests upon those who are in a measure charged with the difficult task of molding a system of education for these great countries that will yield efficient veterinary service. The first generation of veterinary educators in America is rapidly passing away. Its efforts were spent in meeting the demands and grappling with the conditions of a new country and there was little time for it to reckon with the educational methods as they had developed in more mature and cultured Europe. While this first generation manfully battled against the onslaught of disease in the rapidly increasing animal population, discoveries were being made, and methods tested and put into operation, pertaining to veterinary education and practise, of which these new countries were unmindful. At no time in the history of man has a generation witnessed greater revolutions in the theories, facts and methods of a profession than those which occurred in rapid succession in the active lifetime of Alexander Liautard, Andrew Smith, Duncan McEachran and James Law, three of whom still remain as wise counselors among us. These distinguished men have witnessed all that has been accomplished in the acquisition of definite knowledge of specific diseases, sanitary science, the introduction of the newer

[1] A paper presented by the chairman of the Committee on Intelligence and Education of the American Veterinary Medical Association, at its annual meeting, Toronto, August, 1911.

pathology and therapeutics and the development of our veterinary schools and colleges. It is well for us of the present to recognize that these great leaders saw, as did Lowell, that "New times demand new manners and new men and new conditions demand new schools." Law was the first to carry this idea into practise. Smith followed by affiliating with a great university the school brought into form by his own efforts. McEachran, finding it impossible to provide adequate equipment with the financial support forthcoming, closed the doors of his institution, and Liautard is constantly ringing the call for better and more efficient education.

Standing as it were at the close of the first generation and at the beginning of the second, it seems fitting that this association should devote a little time to the consideration of veterinary education in these countries—what it is, its weaknesses, its strength, its opportunities and above all its responsibilities.

It is a reasonable hypothesis that education directed toward the preparation of men for the practise of veterinary medicine does not differ in principle from that for other professions. The laws of educational evolution therefore apply here as elsewhere, and the acquisition of knowledge that goes to make up a so-called learned profession holds exactly the same position here as it does in human medicine, theology or law. The purpose of education is to engender thought, to eliminate dogma, to enthrone facts and laws and to endow one with an intellectual liberty. Accompanying the possession of definite knowledge there is a corresponding moral obligation to use this knowledge for the benefit of mankind. This is especially true with the medical professions.

If one analyzes the present status of veterinary education in America, measured by the course of general educational laws, it will be found that there still remain in our system or systems of instruction many examples of the methods of the unskilled, remnants of faith in the magic power of the by-gone mystic wand, lingering beliefs in the technical ability of the so-called practical man, as well as a powerful undercurrent of forces demanding education for efficiency. This demand for better training must eventually here, as in other fields, cause ignorance to be replaced by knowledge, unfounded opinions to give way to facts and finally banish forever that error in our teaching which assumes that application can go ahead of the knowledge to be applied. We hear much of veterinary science, forgetting that the application of veterinary medicine is an art based upon a well-defined group of sciences, and that, other things being equal, the success of the artist depends upon his knowledge of the sciences upon which the art rests. This is illustrated by the universal fact that in those countries where the most training in the basic sciences is given and demanded practise is correspondingly most successful. In our systems too much emphasis has been and still is placed upon the diploma and all too little upon what it should represent, thus encouraging the erroneous assumption that it is possible to use what one does not possess.

In order to estimate the true worth of our systems of veterinary education, let us in our imagination strike from our knowledge and from the literature the achievements of the devotees of pure science and then ask ourselves what American veterinary education in itself has done to advance specific knowledge of the nature, treatment and prevention of animal diseases. The honest answer to this question would show that much we are wont to claim for our humane profession comes to

us as a heritage from the great leaders in chemistry, physiology and pathology. The analyst finds in many of our systems the presumptuous effort to correlate the basic sciences into a workable unit in men who do not possess the first principles of chemistry, physics and biology and to instruct such undisciplined men in the many complicated topics that must find place in a modern veterinary curriculum in the brief period of a few short months. While perhaps in earlier years, before there were public schools, and when our curricula were less crowded, these methods met the requirements, the time has come when they remind one of the legend of the clock. It is said that in one of the old towers of Europe there was a clock. As time went on the hands dropped off and the figures on the dial became obliterated; but the sexton, grown old in service, ascended the ladder every week and wound the slowly rusting spring and the clock kept ticking, ticking, while all those who came to learn the time of day went away disappointed, for it told them nothing. A like experience, as proved by many statements from agriculturists, is all too often recorded by those who, in trying to save their suffering animals, have witnessed the hopeless efforts of men who have mistaken diplomas for knowledge and who have sought to be practical without possessing the knowledge with which to aid the sick individual to set aright the disharmonies in the physical body.

Although it is easier to tear down than to build up, it is not my purpose to dwell upon the things we wish were not, but rather to point to the broad foundations that have been and are being laid and to the towers of strength and service that sooner or later must rise upon these foundations. The first and most important stone that is being placed in the foundation for a better and more efficient veterinary education is the training of the owners of animals in the basic sciences upon which veterinary art itself is founded. The teaching in chemistry, botany, physiology and bacteriology given in our agricultural colleges is removing from the minds of men the mask concerning the nature of disease and its treatment that superstition has long held in place. The truth uttered by John Hunter centuries ago that diseases should be studied as objects of natural history has been accepted. It is now recognized that when there is a disability of the body or a morbid process there is some physical cause; and that the remedy lies in rendering the inflicted individual some definite assistance to the methods nature herself has provided to defend the body against such irritants, whatever they are, or to heal the injuries produced. The principles of immunity as laid down and demonstrated by Metchnikoff and Ehrlich are being outlined in readers for pupils in the common schools. The U. S. Bureau of Animal Industry, experiment stations and agricultural colleges are popularizing technical knowledge and sending it broadcast throughout the country in bulletins and circulars so that those who escape the college curriculum are caught in the coils of these popular mechanisms for instruction. With a clientele versed in the very sciences that must be applied by the veterinarian, can a practitioner hope for success, or even for a chance of success, if he himself is not in possession of a still greater knowledge of these same subjects?

A second stratum in our foundation is the gradual differentiation of a group of sciences and their special development for the purpose of promoting the practise of veterinary medicine. Until recently, and in certain places, this still obtains, there has been the tendency to instruct students of

agriculture and others in the treatment of animal diseases. "Every man his own veterinarian" has been the slogan of many, and because of the scarcity of properly trained practitioners it seemed for a time to be the only source of relief. Gradually the line of demarcation is appearing between the general scientific knowledge of the layman and that required for the successful practise of veterinary medicine. Further, as people become versed in the biological sciences, they are better qualified to judge of scientific work; but nowhere in general education are men trained in the details of fact and physical law necessary to wrestle with the diagnosis and treatment of animal diseases. The holding up of a professional standard is more and more in evidence. The aphorism that "the treatment of a disease should not be given to a man who can not make the diagnosis" is prevailing more than ever before, and with it great suffering to dumb creation is being avoided.

Nowhere in educational extension work is there more danger than in the effort to popularize knowledge which can not be popularized. Some years since I was asked to prepare an article for a great agricultural encyclopedia on the treatment of all of the diseases of animals. My reply was that I could not do it for two reasons, first, I did not possess the necessary knowledge and, secondly, I would not if I could. Whatever our duties may be, they certainly do not lead us into acts that will encourage uninformed people to interfere with the natural resisting and healing forces of the physical body by the improper application of drugs. As sacred as the Hippocratic oath is the therapeutic axiom, "If we do no good be sure we do no harm." The assumption that a diagnosis can be made by any intelligent individual and that he can apply remedies with hope of success is no longer entertained. The recognition of the line of cleavage between knowledge that can be imparted to and used by the layman and that which can be used effectively only with the full complement of facts which are possessed by the properly trained professional man, is a signal for still better and more lasting achievements.

A third element of strength is the recognition by the existing veterinary schools and colleges that better and more efficient work is demanded of them. Already there is a wide-spread effort to bring about better conditions. As the foundation for a better system of veterinary education has been laid by forces operating largely outside of the profession, it remains for us to build upon this foundation an educational structure adequate to the demands. Many efforts of a more or less spasmodic nature have been put forth to accomplish this. Numerous formulæ have been proposed for the conduct of veterinary schools and colleges. While opinions may differ as to the effectiveness of the various remedies proposed, we may with fairness to all pass from a prescribed formula to the facts and principles that must be reckoned with in securing the desired results. Here we do not differ from human medicine, engineering, agriculture or specialization in any of the sciences. The facts to be considered pertain to the changes in curriculum, methods of teaching and the necessary cost of instruction. The underlying principle is that which governs the growth of knowledge and the discipline of the individual acquiring it.

In former times students acquired their professional knowledge from their preceptors. Later this system obtained in schools where the master in the form of didactic lectures given with more or less ceremony imparted facts considered to be sufficient

for the practitioner. A time came, however, when many discoveries in nature's processes were made and great leaders arose. Those leaders precipitated, as it were, long suspended and hitherto unperceived elements of knowledge so that orderly truth seemed to crystallize in the twinkling of an eye out of what had appeared hitherto but a cloudy mass of facts. Men of this class are not born in every generation; in none are they numerous. Theirs are the master minds. In a strict sense these men are pupils of no masters, but at first they stand alone in expounding new theories. Such men as Virchow, Darwin, Pasteur, Metchnikoff and Ehrlich laid the foundation of rational medicine and brought into the curriculum the consideration of a vast number of topics unknown to their predecessors. These subjects could not be taught by word of mouth only, and consequently laboratories with delicate and expensive apparatus supplemented lectures, and clinics with a great array of instruments of precision were substituted for cases in private practise. Again, to understand the meaning and to profit by these aids the student must be prepared by a training in and a knowledge of the basic sciences. These changes have come about in less than a half century and the lives of men now living span this great epoch-making period.

With the introduction of new subjects and new methods of teaching, the cost of instruction increased. The schools without the equipment can not meet their obligations, nor can they procure the equipment and provide the instruction with the fees that students pay. This is an important fact in higher and professional education everywhere. Many elements enter into this increased cost, the most important of which are expensive equipment and the inability to teach large classes or sections of students and the consequent necessity of providing for units of small numbers. The budgets of our large universities show that it actually costs for every student from two to three times as much as the highest tuition charged, and when the maximum efficiency is attained the expense will be much greater than at present. Recently the president of one of our best technical universities told me that it cost them $450 a year for every man they graduated. It costs our best medical schools from $500 to $1,000 and some of them more a year for every student, and no thoughtful person will assert that efficient veterinary education will cost much if any less. The college which I have the honor to represent expends over $300 annually for every student in addition to the cost of instruction in histology, embryology, chemistry and animal husbandry given by the university, and even with this outlay my heart and head are sorely troubled to satisfy the reasonable demands of the faculty for assistance and equipment with the funds available.

The difficulties involve not only questions of financial support, but also efficient methods for teaching the newer subjects. It often seems that in the development of efficient educational systems the greatest difficulty is the formulation of methods and the enlistment of suitable men for teachers. Some years ago I accepted a position carrying with it the responsibility of teaching pathology and bacteriology in a veterinary college. I went from a research laboratory where I had grown up with the technique and knowledge of certain phases of the subjects. I labored, as have many others, under the delusion that the essential elements could be easily taught. There was no difficulty in securing the interest of the students, but the pangs of disappointment were mine when these same interested men

attempted to apply the knowledge I supposed they possessed, in the actual practise of their profession. Their errors were not more grievous than those of other men, but the things they did and the kind of assistance they sought pointed clearly to a lack of knowledge or understanding at least of the subjects which I believed I had taught with great clearness. This experience has caused me to question the efficiency of many pedagogical methods and to test as best I could different systems of instruction in my own department. The conclusion that seems to be inevitable from the experience of the past is that for the best results the courses in a veterinary curriculum must be dominated by a scientific system of presentation and that the technique, facts and laws of chemistry, anatomy, physiology, bacteriology, pathology, medicine and surgery must be clearly developed before stress can be placed upon the value of fragmentary facts. The difficulty rests not alone in a lack of the knowledge of technique, but quite as much in the inability to apply the principles and to interpret the findings. If veterinary medicine is to benefit the public as it should, it is important that those responsible for the training of men who are to apply the knowledge in practise take fully into account the nature of their teaching. Wherever the true scientific spirit dominates the final results prove to be most helpful. It is not my purpose, nor do I believe it is possible, to outline a schedule to be followed by all. It is, however, within our power to give to veterinary medicine the dignity commensurate with its economic and vital relations to the live-stock interests of the country and to teach it as a group of correlated sciences and not as an aggregation of disconnected facts.

During the last quarter of a century a great revolution has taken place in matters educational, and the period of readjustment is upon us. The problem as presented to us by the rapid bursting forth of enormous numbers of facts and new methods is easily stated. How can young men be fitted for their profession for $125 a year when it actually costs from three to four times as much to provide the necessary instruction? This is a problem that almost chills our enthusiasm. It is so sudden, so contrary to precedent, so unreasonable from our accustomed point of view, that there is an inclination to dispute it. However, as science can not rise above natural law but must work through it, so veterinary education can not depart from the laws that govern higher education, but must follow them. If the veterinary profession attains its rightful place among the learned professions it must, like the others, adjust itself to the requirements of the times. We are engaged in professional work, not selfish enterprise. The same problem confronts human medicine, and our deliverance is equally as hopeful as that of the sister profession.

Those who have sought for a remedy have found but two solutions to the perplexing problem, namely, the endowment of our schools, either directly or by affiliation with universities or by state assistance. In the United States and Canada private endowments for veterinary schools are not numerous. If the wealthy are not disposed to aid this cause, why can not the members of the profession itself form active alumni associations for the purpose of raising funds to make it possible for their own schools to obtain the necessary financial support? Such a scheme is already in operation in several of our largest universities, and I see no reason why it should not work with veterinary colleges. So long as satisfactory technical education can not be obtained for the fees which most stu-

dents can pay, it is fair that, after receiving the benefit of such training, the alumni should respond willingly and generously. Because such an education is expensive, and because through the wisdom and generosity of certain people provision has been made that boys with little or no money can obtain it, there is no reason why the recipients should not repay the institution for what they have already received.

On the continent of Europe government control has long since solved this difficulty. In America the states and governments are beginning to recognize their responsibility in this matter, but nowhere to the extent the work demands. However, the sentiment is right, and our legislators are waiting for veterinarians to point out the needs, and indicate the course to be followed. I do not know of any line of educational effort that has been more effective in bringing to its aid state assistance than the veterinary cause. There is every reason to expect that when the veterinary profession shows the owners of the more than $4,000,000,000 worth of live stock in the United States alone what can be done to save annually the millions of loss from disease, and when we demonstrate to the health authorities and the public the sanitary importance of a veterinary training, this profession will receive its just recognition. The opportunities for the veterinarian to serve the people are so great that when the profession fully meets its responsibilities, and when leaders appear to solve the problems still waiting solution, veterinary education will become the most idealistic and realistic of the learned professions, and the funds necessary to provide such service will be forthcoming. The need of the time is educational leaders to formulate systems and to develop the many avenues through which we can render service to our clients, our state and our nation. As devotees of veterinary science we yield precedence to none in honesty and lawfulness of purpose or faithfulness of service in the bitter conflict humanity has ever waged and ever must wage against pain and disease.

As already stated, our difficulties are not restricted to finances. There are perplexing pedagogical tasks before us. In every transition period there are dangers often overlooked until it is too late. Medical instruction and practise are changing. The new theories, diagnostic aids and therapeutic agents fairly glisten with possible victories. The recent graduates going out with this new armor are like the unhappy knights of old in the search for the Holy Grail in that they feel their zeal and power to be sufficient to overcome all obstacles. The pendulum of knowledge, like that which beats time, swings from one extreme to the other. Specific knowledge of etiology, the reaction of the tissues, the definite laboratory methods for diagnosis, are accompanied by dangers, for as yet we see only in part. Already the experience with tuberculin, the agglutination test and the reliance on certain findings in blood examinations, point to the fact, which must not be overlooked, that in all of the so-called methods of precision there are sharply defined limitations which sooner or later will be revealed. Again there is in evidence the danger of superficial training in the practical branches, such as theory and practise, because of a dependence on and an over-confidence in laboratory findings or the newer remedies. All too frequently we receive at our laboratory a piece of hide, a bit of intestine or a smear from a liver, sent that we may diagnose the disease from which the animal died. In rare instances this can be done, but it should be clearly understood that the only thing laboratory methods can do is to enable one to see deeper into the condition

than he otherwise could. If the trouble is in the bone, the nervous system or the kidney, a piece of the stomach usually tells us nothing. The microscope or the culture tube can show us only what is present and for assistance they must be used in conjunction with other information or to verify or refute suspicion. This means, therefore, that men who are to become practitioners must be trained in the knowledge of specific etiology, the newer pathology and therapeutics, *in addition to and not as a substitute* for the training in thorough systems of physical examination and in close observation of signs and symptoms in diagnosis and treatment. This not only increases the responsibilities of our teachers, but also demands that technical professional knowledge shall be grafted upon well-trained and noble men. There is no other profession where accuracy, correct interpretation and application are of greater significance than they are in this, yet there is no other where men are elevated to positions of responsibility with so little real preparation. We seem to have forgotten that in the acquisition of knowledge and the coming into an understanding of a profession, the element of time and the discipline of routine work and research are as essential as they are in a science like chemistry or physics.

I have dwelt somewhat at length upon the difficulties in bringing into action men who will meet the demands, improve the opportunities and fulfill the responsibilities of the veterinary profession. If these difficulties are analyzed, it will be found that they are temporary and incident to the transition stage of our knowledge, methods of instruction and the newer conception of the important work of the veterinarian. These all point clearly to the opportunity for veterinary service equal to that of any other occupation or profession. The watchword of to-day is the prevention of disease quite as much as its cure and when this dual purpose becomes fully recognized the necessary means will be forthcoming. While there is much to be accomplished, while our problems are difficult and our burdens sometimes seem greater than we can bear, my voice has proved a recreant servant if any tones of doubt, or fear of ultimate victory, have marred this discussion. There are many reasons to believe that the time will soon come when there will be an American system of veterinary education, laws and practise that will take first place in the world-wide effort to secure the highest possible efficiency in veterinary service.

Veranus A. Moore

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

ADDRESS TO THE BOTANICAL SECTION[1]

Greatly as I prize the honor done me by the Council of the British Association in electing me to the office of President of the Botanical Section, my gratification has been heightened by the knowledge that the meetings of this section would be graced by the presence of the distinguished group of Continental and American botanists who have just taken part in the International Phytogeographical Excursion to the British Isles.

I am sure that I am voicing the unanimous feeling of the section in offering them a hearty welcome to our deliberations, and, in conveying to them our sense of the honor they have done us by their acceptance of the invitation of this association, I would like to express our hope that by their participation in our proceedings they will help us to promote the advancement of botanical science, for which purpose we are met together.

[1] Portsmouth, 1911.

In view of these special circumstances under which we forgather, it may seem inappropriate if I deal, as I shall be doing, in my presidential address mainly with fossil plants, with the study of which I have been for some time occupied; but I need hardly assure our visitors that, while we entertain some feelings of satisfaction at the contributions made during the past half century towards our knowledge of extinct flora of Britain, yet, as the later sittings of this section will show, and as they have no doubt realized during their peregrinations through this country, our botanical sympathies and energies are by no means limited to this branch of botanical study. Moreover, I hope during the course of my address to point out the ecological interest which is afforded by certain aspects of paleobotany.

On the sure foundations laid by my revered predecessor, the late Professor Williamson, so vast a superstructure has been erected by the active work of numerous investigators that I must limit myself in this address to exploring only certain of its recesses, and I shall consequently confine myself to some aspects of paleobotany which have either not been dealt with in those able expositions of the subject given to this section by previous occupants of this presidential chair, or which may be said to have passed since then into a period of mutation.

The great attractiveness of paleobotany, and the very general interest which has been evinced in botanical circles in the progress of recent investigations into the structure of fossil plants, are due to the light they have thrown upon the relationship and the evolution of various groups of existing plants. It was the lasting achievement of Williamson to have shown, with the active cooperation of many working-men naturalists from the Lancashire and Yorkshire coal-fields, that the structure of the coal-measure plants from these districts can be studied in microscopic preparations as effectively as has been the case with recent plants since the days of Grew and Malpighi. Indeed, had Sachs lived to continue his marvelous historical account of the rise of botanical knowledge up to the years 1880 or 1890, he would undoubtedly have drawn attention to the remarkable growth of our knowledge of extinct plants gained by Binney and Williamson from the plant remains in the calcareous nodules of English coal-seams, and by Renault from the siliceous pebbles of Autun. We are not likely to forget the pioneer work of these veterans, though since then investigations of similar concretions from the coal deposits of this and other countries have been undertaken by numerous workers and have revealed further secrets from that vast store of information which lies buried at our feet.

The possibilities of impression material had indeed been practically exhausted in 1870, and further advance could only come from new methods of attacking the problems that still remained to be solved. The most striking recent instance of the insufficiency of the evidence of external features alone was Professor Oliver's demonstration of the seed-bearing nature of certain fern-like plants, based on microscopical comparison of the structure of the cupule of *Lagenostoma,* with the fronds of *Lyginodendron,* after which discovery confirmatory evidence speedily came to hand from numerous plant impressions examined by Kidston, Zeiller, and other observers.

Undoubtedly in the hands of a less competent and far-sighted observer than Williamson, the new means of investigation might have proved as misleading as the old method had been in many instances. Indeed, as is well known, the recognition

in the sections of *Calamites* and *Sigillarias* of the presence of secondary wood had caused Brongniart to place these plants among conifers, owing to his belief that no vascular cryptogams exhibited exogenous growth in thickness. It required all Williamson's eloquence and pugnacity to convert both British and French paleobotanists to his views, ultimately accepted with such handsome acknowledgment by *Grand' Eury,* one of his antagonists, in his "Géologie et Paleontologie du Bassin Houiller du Gard."

It is curious that Grand' Eury refers in his introduction to the discovery of traces of secondary growth in *Ophioglossum,* and not to that of *Isoëtes,* a plant much more nearly related, as we now believe, to the Lepidodendraceæ, and the structure of which had been so thoroughly investigated by Hofmeister. Williamson, it is true, refers to the secondary growth in the stem of *Isoëtes* in his memoir on *Stigmaria,* but compares it with the periderm-forming cambium of that plant, and does not therefore recognize any agreement in the secondary growth of these two plants.

Adopting von Mohl's interpretation of the root-bearing base of the *Isoëtes* plant as a "caudex descendens," Williamson instituted a morphological comparison between the latter and the branching *Stigmaria,* and came to the conclusion that they were homologous structures, a view which, as we heard at Sheffield, is supported by Dr. Lang on the strength of a reexamination of the anatomy of the stock of *Isoëtes.* If we do not accept Williamson's interpretation of the Stigmarian axis as a downward prolongation of caulome nature, the question remains open whether this underground structure represented a leafless modification of a normal leaf-bearing axis as is known in the leafless rhizomes of *Neottia* and other saprophytic plants, or whether the Stigmarian axes were morphological entities of peculiar character. Grand' Eury, in comparing them with the rhizomes of *Psilotum,* accepted the former alternative and, apart from morphological considerations, was led to this view by the fact that he had observed aerial stems arising in many instances, as buds on the horizontal branches of *Stigmaria.* Confirmation of this mode of growth is still required, but it is quite conceivable that there may have been a mode of vegetative reproduction in the *Stigmariæ* analogous with that of *Ophioglossum.*[2]

The alternative interpretation of the Stigmarian axes as special morphological entities has received weighty support from Scott and Bower, who consider them comparable to the rhizophores of *Selaginella,* which, as is well known, may either be root-bearers, or under certain circumstances become transformed into leafy shoots. This peculiarity has led Goebel to regard them as special members, somewhat intermediate between stems and roots. But though they might therefore be regarded as of a primitive nature, the rhizophores of the Selaginellaceæ seem such specialized structures that I incline to agree with Bower that, as far as their correspondence with *Selaginella* is concerned, the Stigmarian axes would agree most closely with the basal knot formed on the hypocotyl of *Selaginella spinulosa.* Seeing, however, that the nearest living representative of the Lepidodendraceæ is in all

[2] It is of interest in this connection to note that Potonié has recently put forward the suggestion that many of these vertical outgrowths from the more or less horizontal Stigmarian axes, some of which, as figured and described by Goldenberg, taper off rapidly to a point, without any trace of ramification, may be comparable with the conical "knees" of *Taxodium,* and represent woody pneumatophores so common in the swamp cypress and other swamp-inhabiting trees.

probability *Isoëtes*, which Bower has aptly summarized as like "a partially differentiated *Lepidostrobus* seated upon a Lepidodendroid base," we must inevitably consider the root-bearing base of *Isoëtes* as homologous with the branching axes of *Stigmaria*, whatever their morphological nature may have been, and perhaps we shall be on the safest ground if we consider them both as different expressions of the continued growth of the lower region of the plant, which appears to have been a primary feature in the morphology of both these members of the Lycopodiales.

The somewhat considerable difference in external appearance between the homologous organs of these two plants may be considered bridged over by the somewhat reduced axes of *Stigmariopsis* and by the still more contracted base of the Mesozoic *Pleuromoia*, which, in spite of its very different fructification, we may unhesitatingly compare with *Isoëtes* as far as its root-bearing axis is concerned.

I was inclined at one time to seek an analogy for the Stigmarian axis in that interesting primitive structure, the protocorm of *Phylloglossum*, and of embryo Lycopods; but I now consider that the resemblances are largely superficial, and do not rest upon any satisfactory anatomical correspondence.

One of the features which has caused some divergence of opinion in the past as to the morphology of the Stigmarian axis has been the definite quincuncial arrangement and the apparent exogenous origin of the roots borne on these underground organs. Schimper, indeed, considered these two features so characteristic of foliar organs that he suggested that these so-called "appendices" might possibly be metamorphosed leaves. Not quite satisfied with this view, Renault endeavored to establish the existence of two types of lateral organs on the Stigmarian axis, true roots with a triarch arrangement of wood and root-like leaves of monarch type. Williamson, however, clearly showed that the apparent triarch arrangement was really due to the presence at two angles of the metaxylem of the first tracheids of secondary wood, and reasserted the existence of only one type of appendicular organs, agreeing so closely, both in structure and in their orientation to the axis, on which they were borne, with the roots of *Isoëtes* that it would be impossible to deny the root nature of the Stigmarian "appendices" without applying the same treatment to the roots of *Isoëtes*.

Still, so distinguished a paleobotanist as Solms Laubach, after a careful weighing of all the available evidence, continued to uphold Schimper's view of the foliar nature of these outgrowths, both in his "Paleophytologie" and in his memoir on *Stigmariopsis*, in which he stated that he was in complete agreement with Grand' Eury's conclusion: "Que ces organes sont indistinctement des rhizomes et que les Sigillaires n'avaient pas de racines réelles, ainsi que *Psilotum*." Indeed, in reviewing the account I gave of the occurrence of a special system of spiral tracheids in the outer cortex of the Stigmarian rootlets, Count Solms drew attention to their similarity to the transfusion tissue of Lepidodendroid leaves, and asserted that we have here a further indication of the former foliar nature of these rootlets. Personally, I still adhere to the belief, expressed at the time, that these peripheral cortical tracheids represent a special development required by a plant with an aquatic monarch root of the *Isoëtes* type and a large development of aerial evaporating surface. The fact that the lateral outgrowths from the Stigmarian axis have been generally considered to be exogenous is not a valid

argument against their root nature, as the same origin is ascribed to the roots of *Phylloglossum* and to those produced on the rhizophores of *Selaginella*. Probably, indeed, as Bower points out in his masterly exposition of the "Origin of a Land Flora," in dealing with the Lycopodiales, "the root in its inception would, like the stem of these plants, be exogenous." According to the "recapitulation theory," indeed, the exogenous formation of the roots in the embryo of certain Lycopods, as well as of the first root of *Isoëtes* and the first root of the Filicales, might be regarded as the retention of a more primitive character in these particular organs. The roots of *Stigmaria*, even if exogenous, might therefore merely represent a more ancestral stage. This difference between the roots of *Isoëtes* and the rootlets of *Stigmaria* may, however, be more apparent than real, for my colleague, Dr. Lang, has drawn my attention to the fact that there appear to be in *Stigmaria* remnants of a small-celled tissue on the outside of what has generally been taken to be the superficial layer of the Stigmarian axis, and a careful investigation of this point inclines me to agree with him that very probably the Stigmarian rootlets were actually formed like those of *Isoëtes*, somewhat below the surface layer, which, after the emergence of the rootlets, became partially disorganized. Should this surmise prove correct when apices of *Stigmaria* showing structure come to light, the last real difference between the rootlets of *Isoëtes* and the rootlets of *Stigmaria* will have disappeared, and the view for which Professor Williamson so strongly contended will be finally established.

While a careful comparison of *Isoëtes* with the extinct Lycopodiaceous plants may be taken to finally settle its systematic position, the Psilotaceæ have been somewhat disturbed by such comparisons. Placed formerly without much hesitation in the phylum Lycopodiales, certain features in their organization, such as the dichotomy of their sporophylls, and the structure of their fructification generally have suggested affinity with that interesting group of extinct plants, the Sphenophyllales. Their actual inclusion in this group by Thomas and by Bower may seem, perhaps, somewhat hazardous, considering the differences existing between the Psilotaceæ and *Sphenophyllum;* and the more cautious attitude of Seward, in setting up a separate group for these forms, seems on the whole more satisfactory than forcing these aberrant relatives of the Lycopods into the somewhat Procrustean bed of Sphenophyllales, which necessitates the minimizing of such important differences as the dichotomous branching of the axis and the alternate arrangement of their leaves, though the latter character allows, it is true, of some bridging over. But, even adopting this more cautious attitude, the study of the Sphenophyllales has been of great help in coming to a clearer understanding of certain morphological peculiarities of the Psilotaceæ, quite apart from the flood of light which this synthetic group of Sphenophyllales has thrown upon the relationship of the Lycopodiales to the Equisetales.

More far-reaching in its bearing on the relationships of existing plants has been the study of those interesting fern-like plants which seem to show in their vegetative organs a structure possessing both fern-like and Cycadian affinities. Full of interest as these so-called Cycadofilices were in their vegetative organization, they were destined to rivet on themselves the attention of all botanists by the discovery of their fructifications. No chapter in the recent history of paleobotany is more thrill-

ing than the discovery, by the patient and thorough researches of Professor Oliver, of the connection between *Lyginodendron* and the well-known paleozoic seed, *Lagenostoma.* With Dr. Scott as sponsor, this new and startling revelation met with ready acceptance, and, thanks to the indefatigable energies of paleobotanists, no fossil fern seemed at one time safe from possible inclusion among the Pteridospermæ.

The infectious enthusiasm with which the discovery of the seed-bearing habit of the Lyginodendreæ and the Medullosæ was greeted carried all before it, and we in England, particularly, have perhaps not looked carefully enough into the foundations upon which rested the theory that these groups form the "missing links" between the ferns and cycads. A criticism against the wholesale acceptance of this view has been put forward by Professor Chodat,[3] of Geneva, that distinguished and versatile botanist, whom we have on several occasions had the pleasure of welcoming in our midst. Couched throughout in friendly and courteous language, and full of admiration for the work of those who were concerned in the establishment of the group of Cycadofilices, now termed Pteridospermæ, Professor Chodat suggests that English paleobotanists have not sufficiently appreciated the work of Bertrand and Corneille[4] on the fibro-vascular system of existing ferns, and have not revised, in the light of the researches of these French investigators, the interpretation given to the arrangement of the primary vascular tissues of *Lyginodendron.* In Chodat's opinion the structure of the primary groups of wood found in the stem and in the double leaf-trace of this plant is not directly comparable with the arrangement found in the petiole of existing Cycads. In the latter the bulk of the metaxylem is centripetal, while we have in addition a varying amount of small-celled centrifugal wood towards the outside of the protoxylem, and though separated from it by a group of parenchymatous cells, the bundle may be conveniently described as mesarch. In *Lyginodendron,* and the same applies to *Heterangium,* the primary bundles of the stem appear at first sight to be mesarch too, but in Chodat's opinion, if I understand him correctly, the metaxylem is exclusively centrifugal in its development, but, widening out and bending inwards again, in form of the Greek letter ω, the two extremities of the metaxylem are united on the inside of the protoxylem, forming an arrangement described by Bertrand and Corneille in the case of several fern petioles under the name of "un divergeant fermé."

Several details of structure, such as the type of pitting of the metaxylem elements and the separation of the protoxylem from the adaxial elements of metaxylem by parenchymatous cells, confirm Chodat in his view that the primary bundles of *Lyginodendron* are not really mesarch, and that the stem of *Lyginodendron* is essentially Filicinean in nature. Chodat cites other characters, such as the presence of sclerized elements in the pith, and the absence of mucilage ducts, in support of his view of the purely filicinean affinities of the Lyginodendreæ. The presence of secondary thickening in *Lyginodendron* he regards not as indicative of Cycadian affinity, but merely as another instance of secondary growth in an extinct Cryptogam, taking up very much the position of

[3] Chodat, R., "Les Ptéropsides des temps paléozoïques," *Archives des Sciences physiques et naturelles,* Genève, Tome XXVI., 1908.

[4] Bertrand, C. E., and Corneille, F., "Etude sur quelques characteristiques de la structure des filicinées actuelles," *Travaux et mémoires de l'Université de Lille,* 1902.

Williamson in his earlier controversy with French botanists with regard to the secondary thickening of *Calamites* and Lepidodendreæ. Chodat is also at variance with Kidston and Miss Benson as to the nature of the microspores borne on the fronds of *Lyginodendron* or *Lyginopteris*, as he prefers to call this plant. He certainly figures some very fern-like sporangia, attached to the fronds of *Lyginodendron*, but any one who has worked with the very fragmentary and somewhat disorganized material contained in our nodules knows how difficult it is to be absolutely certain of structural continuity. Neverthless, a reinvestigation of the whole question of the microsporangia of *Lyginodendron* seems to me clearly called for by the publication of Chodat's figures.

As regards the seed-bearing habit of *Lyginodendron*, Chodat adopts wholeheartedly Oliver's correlation of *Lagenostoma* with the fronds of *Lyginodendron*, but would regard the seed, apparently devoid of endosperm at the time of pollination, as a somewhat specialized macrosporic development, of more complex structure, but analogous in its nature to the seed-like organ exhibited by *Lepidocarpon* in another phylum of the Pteridophyta. "In any case," he concludes, "the origin and the biology of this kind of seed must have been very different from those of the seeds of the Gymnosperms."

This contention, based mainly on the tardy development of the endosperm in *Lagenostoma*, is the least weighty part of Chodat's criticism, for it has never been asserted that the seeds were identical with those of existing Cycads. We know that the seed-habit was adopted by various groups of Vascular Cryptogams, and it is revealed in fossil plants in various stages of evolution, so that it may be readily presented to us at a special stage of its evolution in *Lyginodendron*. Moreover, we must remember that in so highly organized a Gymnosperm as *Pinus*, the macrospore itself is not fully developed at the time of pollination. Though not suggesting this as a primitive feature in the case of the pine, we can well imagine how, by a gradual process of "anticipation," the prothallus might become established before pollination in any group of primitive seed-bearing plants. There are other more specialized rather than primitive features in the complex structure of *Lagenostoma* which might with much more reason be invoked, to show that the seed of *Lyginodendron* does not form a step in the series of forms leading to the Cycadian ovule.

But leaving this point out of consideration, Chodat brings forward some strong reasons for his conclusions that the Lyginodendreæ were plants possessing stems of purely fern-like structure, increasing in thickness by means of a cambium, that their foliage was of filicinean structure, but provided with two kinds of sporangia, microsporangia similar to those of Leptosporangiate ferns, and macrosporangia of specialized type, containing a single macrospore. This group, therefore, Chodat regards as a highly specialized group of ferns, which, he considers, shows no particular connection with the Cycads, and which may have formed the end in a series of highly differentiated members of the Filicineæ.

Of the Medullosæ, on the other hand, Chodat takes a very different view. Both in the structure of their primary and secondary growth, as well as in their polystely, he sees close affinity of these forms to the Cycads, borne out by smaller secondary features, such as the presence of mucilage ducts, and the simple form of pollen-chamber. Chodat considers the agreement of the Medullosæ with the Cycadaceæ to be so

close that he regards them as Protocycadeæ, the fern-like habit being restricted to the position of the sporangia on the vegetative fronds. *Medullosa,* therefore, would be only one link in the chain connecting the Cycads with the Filicales, and a link very near the Cycadian end of that chain. Other forms more closely connected with the Filicinean phylum are still to be sought.

In bringing Professor Chodat's views to your notice, I do not wish to urge their acceptance, but his criticism seems to me sufficiently weighty to demand a careful reconsideration of the structure and affinities of the Lyginodendreæ, which, whatever may be their ultimate position in our scheme of classification, will continue in the future, as they have done in the past, to command the attention of all botanists interested in the evolution of plant life.

If the whole-heartedness with which we in England received the theory of the Cycadian affinity of *Lyginodendron* has laid us open to friendly criticism, I am afraid some of us may be accused of exceeding the speed-limit in our rapid acceptance of the Cycadoidean ancestry of the Angiosperms. Ever since Wieland put forth the suggestion in his elaborate monograph of the "American Fossil Cycads" that "further reduction and specialization of parts in some such generalized type, like the bisporangiate strobilus of *Cycadoidea,* could result in a bisexual angiospermous flower," speculation as to the steps by which the evolution might have been brought about has been rife, and Hallier in Germany and Arber and Parkin in England have put forward definite schemes giving probable lines of descent. Arber and Parkin in their criticism and detailed suggestions connect phylogenetically with the Bennettitales, the Ranales, as primitive Angiosperms, and displace from this position the Amentales and Piperales, which were regarded by Engler as probably more closely related to the Proangiosperms. Of course, the resemblance between the amphisporangiate, or, as I should prefer to call it, the heterosporangiate "strobilus" of *Cycadoidea,* and the flower, say, of *Magnolia* is very striking, and the knowledge we have gained of the structure and organization of the Bennettitales certainly invites the belief in a possible descent of the Angiosperms from this branch of the great Cycadian plexus; but the ease with which the flower of the Ranales can in some respects be fitted on to the "flower" of *Cycadoidea* raises suspicion. Critics of the Arber-Parkin hypothesis may possibly incline to the view that "truth is often stranger than fiction," and that the real descent of the Angiosperms may have been much less direct than that put forward in these recent hypotheses. The particular view of the morphology of the intraseminal scales and seed pedicles adopted by Arber and Parkin is, as they admit, not the only interpretation that can be put upon these structures, and the views on this point will probably remain as various as are those of the female cone of *Pinus.* Even if we regard the ovulate portion of the Cycadoidean "flower" as a gynecium, and not as an inflorescence, we are bound to admit, as do Arber and Parkin, that it is highly modified from the pro-anthostrobilus type with a series of carpels bearing marginal ovules. *Cycadoidea* was evidently a highly specialized form, and may well have been the last stage in a series of extinct plants.

Arber's very sharp separation of mono- and amphisporangiate Pteridosperms does not seem to me quite justified. Amphisporangiate forms may have been preserved, or may have arisen anew in various groups of Pteridosperms or in their descendants. Heterospory, we know, orig-

inated independently in at least three of the great phyla of vascular Cryptogams, and originally, no doubt, the same strobilus contained both macro- and microsporangia, as was the case in *Calamostachys Casheana,* in the strobili of most Lepidodendraceæ, and as is still the case in the strobili of *Selaginella* and in *Isoëtes.* Even in the existing heterosporous Filicineæ, micro- and macrospores are found on the same leaf and on the same sorus; and though in the higher Cryptogamia and the lower Phanerogamia there may have been a tendency to an iso-sporangiate condition, yet, as the two kinds of spores are obviously homologous in origin, nothing is more natural than an occasional reversion to a heterosporangiate fructification. Thus in the group of Gymnosperms we have many instances of the occurrence of so-called androgynous cones. In 1891, at the meeting of the British Association in Leeds, I described such amphisporangiate cones which occurred regularly on a *Pinus Thunbergii* in the Royal Gardens of Kew, and only this spring I was able to gather several hermaphrodite cones of *Larix Europea.* They have, of course, been observed and described by many authors for a variety of Gymnosperms. What more likely than that many extinct Gymnosperms may have developed heterosporangiate fructifications? It is not necessary, therefore, to fix on one group of ancestors for the origin of all existing Angiosperms. Indeed, the great variety of forms, both of vegetative and reproductive organs, which we meet with in the Angiosperms, not only to-day, but even in the Cretaceous period, in which they first made their appearance, warrants, I think, the belief in a polyphyletic origin of this highest order of plants. It is no doubt true, as Wieland points out "that the plexus to which *Cycadoidea* belonged, as is the case in every highly organized plant type, presented members of infinite variety," and, indeed, so far as the vegetative organization goes, we know already, through the labors of Nathorst, of such a remarkable form as *Wielandiella angustifolia,* while Wieland has shown us a further type in his Mexican *Williamsonia.* Nevertheless, these diverse forms all agree in the structure of their gynecium, the particular organ which is not so easy to bring into line with that of the Angiosperms.

I am quite alive to, though somewhat sceptical of, the possibility of a direct descent of the Ranales from the Cycadoideæ, but my hesitation in accepting Arber and Parkin's view of the ancestry of the Angiosperms is enhanced by the consideration that it seems almost more difficult to derive some of the apparently primitive Angiosperms from the Ranales, than the latter from Cycadoidea. Indeed, this common origin of Angiosperms from the Ranalian plexus will, I feel sure, prove the stumbling-block to any general acceptance of the Arber-Parkin theory. It is easy enough to assume that all Angiosperms with the unisexual flowers have been derived by degeneration or specialization from forms with hermaphrodite flowers of the primitive Ranalian type, but unfortunately some of these degenerate forms possess certain characters which appear to me to be undoubtedly primitive.

It is difficult for those who accept Bower's view of the gradual sterilization of sporogenous tissue not to regard the many-celled archesporium in the ovules of *Casuarina* and of the *Amentales* as a primitive character, and though, as Coulter and Chamberlain point out, this feature is manifested by several members of the Ranunculaceæ and Rosaceæ, as well as by a few isolated Gamopetalæ, its very widespread occurrence in the Amentales seems

to indicate its more general retention in this group of plants, and does not agree readily with the theory that these unisexual orders are highly specialized plants, with much-reduced flowers. The possession of a multicellular archesporium is, however, not the only primitive character exhibited by some of the unisexual orders of the Archichlamydeæ. Miss Kershaw[5] has shown, in her investigation of the structure and development of the ovule of *Myrica,* that in this genus, which possesses a single erect ovule, the integument is entirely free from the nucellus, and is provided with well-developed vascular bundles, in both of which features it resembles very closely the paleozoic seed *Trigonocarpus.* The same features were shown, moreover, by Dr. Benson[6] and Miss Welsford to occur in the ovules of *Juglans regia* and in a few allied genera, such as *Morus* and *Urtica.* Also in a large number of Amentales with anatropous ovules (*Quercus, Corylus, Castanea,* etc.), Miss Kershaw has demonstrated the occurrence of a well-developed integumentary vascular supply. No doubt a further search may reveal the occurrence of this feature in some other dicotyledonous ovules, but in the meantime it seems difficult to believe that such a primitive vascular system, which the Amentales share with the older Gymnosperms, would have been retained in the catkin-bearing group, if it had undergone far-reaching floral differentiation, while it had disappeared from the plants which in other respects remained primitive. It would be still more difficult to imagine that it had arisen in the Amentales subsequently to their specialization.

There are other structural characters and general morphological considerations, which I have not time to deal with, which underlie the belief in the primitiveness of the Amentales and some allied cohorts, and I trust they will be set forth in detail by a better systematist than I can claim to be. My object in bringing the matter forward at all is to point out some of the difficulties which prevent me from accepting a monophyletic origin of the Dicotyledons through the Ranalian plexus.

One of these difficulties lies in the relationship of the Gnetales to the Dicotyledons. Arber and Parkin have recently made the attempt to gain a clearer insight into the affinities of this somewhat puzzling group by applying to it the "strobilus theory[7] of Angiospermous descent." The peculiar structure of the flowers of *Welwitschia* lends itself particularly well to a comparison with those of *Cycadoidea,* and a good case can no doubt be made out for a hemiangiospermous ancestry of this member of the Gnetaceæ, and by reduction the other members, in many respects simpler, might be derived from a similar ancestor, though probably, as far as *Ephedra* and *Gnetum* are concerned, an equally good, if not better, comparison might be made with *Cordaites.* But even supposing we admit the possibility of a derivation of the Gnetales from an amphisporangiate Pteridosperm, I think the Amentales merit quite as much as the Gnetales to be considered as having taken their origin separately from the Hemiangiospermæ, and not from the Ranalian plexus. I find this view has been put forward also by Lignier[8] in his attempt to reconstruct the phylogenetic history of the Angiosperms, and I feel strongly that

[5] *Annals of Botany,* Vol. XXIII., 1909.

[6] *Ibid.*

[7] Arber, E. A. N., and Parkin, J., "Studies on the Evolution of Angiosperms," "The Relationship of the Angiosperms to the Gnetales," *Annals of Botany,* Vol. XXII., 1908.

[8] Lignier, O., "Essai sur l'Evolution morphologique du Règne vegetal," *Bull. de la Soc. Linnéenne de Normandie,* 6 sér., 3 vol., 1909, reimprimé février, 1911.

such a polyphyletic descent, whether from the more specialized anthrostrobilate Pteridospermæ or from several groups of a more primitive Cycado-Cordaitean plexus, is more in accordance with the early differentiation of the Cretaceous Angiosperms, and with the essential differences existing now in the orders grouped together as Archichlamydeæ.

Attempts at reconstructing the phylogeny of the Angiosperms are bound to be at the present time largely speculative, but we may possibly be on the threshold of the discovery of more certain records of the past history of the higher Spermaphyta, since Dr. Marie Stopes has commenced to publish her investigations of the cretaceous fossil plants collected in Japan, and Professor Jeffrey has been fortunate enough to discover cretaceous plant-remains showing structure in America. The former have already provided us with details of an interesting Angiospermic flower, and if the latter have so far only yielded Gymnosperms, we may at all events learn something of the primitive forms of these plants, the origin of which is still as problematical as is that of the Angiosperms.

I trust that the criticisms I have made of the theory put forward by Messrs. Arber and Parkin will not be taken as a want of appreciation on my part of the service they have done in formulating a working hypothesis, but merely as an expression of my desire to walk circumspectly in the very alluring paths by which they have sought to explore the primeval forest, and not to emulate those rapid but hazardous flights which have become so fashionable of late.

While the description of new and often intermediate forms of vegetation has aroused such wide-spread and general interest in paleobotany, other and more special aspects of the subject have not been without their devotees, and have proved of considerable importance. Morphological anatomy has gained many new points of view, and our knowledge of the evolution of the stele owes much to a careful comparison of recent and fossil forms, even when these investigations have produced conflicting interpretations and divergent views.

Another promising line of paleobotanical research lies in the direction of investigations of the plant tissues from the physiological and biological points of view. Happily, the vegetable cell-wall is of much greater toughness than that of animal cells, and in consequence the petrified plant-remains found in the calcareous nodules are often so excellently preserved that we can not only study the lignified and corky tissues, but also the more delicate parenchymatous cells. Even root-tips, endosperm and germinating fern-spores are often so little altered by fossilization that their cells can be as easily studied as if the sections had been cut from fresh material. It is this excellence of preservation which has enabled us to gain so complete a knowledge of the anatomy of paleozoic plants, and since the detailed structure of plant organs is often an index of the physical conditions under which the plants grew, we are able to form some opinion as to the habitat of the coal-measure plants. Though a beginning has already been made in this direction by various authors, we have as yet only touched the fringe of the subject, and, as Scott points out in the concluding paragraph of his admirable "Studies," the biology and ecology of fossil plants offer a wide and promising field of research. Such studies are all the more promising, as we now have material from such widely separated localities as the Lancashire coal-field, Westphalia, Moravia and the Donetz Basin in Russia.

Now that it has been definitely shown by

Stopes and Watson that the remains of plants are sometimes continuous through adjacent coal-balls, we may safely accept their conclusion that these calcareous concretions were in the main formed *in situ*, and that the plant-remains they contain represent samples of the vegetable débris of which the coal-seam consists. We have in these petrifactions, therefore, an epitome, more or less fragmentary, of the vegetation existing in paleozoic times on the area occupied by the coal seam, and the Stigmarian roots in the underclay, as well as other considerations, lead us to believe that the seam more frequently represents the remains of the coal-measure forest carbonized *in situ*. While this seems to be the more usual formation of coal-seams, it is obvious from the microscopic investigations of coal made by Bertrand, and as has recently been so clearly set forth by Arber in his "Manual on the Natural History of Coal," that in the case of bogheads and cannels the seam represents metamorphosed sapropelic deposits of lacustrine origin. In other cases, again, considerations of the nature of the coal and the adjacent rocks may incline us to the belief that some, at any rate, of the deposits of coal may be due to material drifted into large lake-basins by river agency.

Broadly speaking, however, and particularly when dealing with the seams from which most of our petrified plant-remains have been collected, we may consider the coal as the accumulated material of paleozoic forests metamorphosed *in situ*. What, then, were the physical and climatic conditions of these primeval forests? The prevalence of wide air-spaces in the cortical tissues of young Calamitean roots, as indeed their earlier name Myriophylloides indicates, leads us to believe that, as in the case of many of their existing relatives, they were rooted under water or in waterlogged soil. We gather the same from the structure of *Stigmaria*, while the narrow xerophytic character of the leaves at any rate of the tree-like *Calamites* and *Lepidodendra* closely resembles the modifications met with in our marsh plants. It has been suggested by several authors that the xerophytic character of the foliage of many of our coal-measure plants may be due to the fact that they inhabited a salt marsh. A closer examination of the foliage, however, of such plants as *Lepidodendron* and *Sigillaria* does not reveal the characteristic succulency associated with the foliage of most Halophytes, and in view of the absence of such water-storing parenchyma, the well-developed transfusion-cells of the Lepidodendreæ can only be taken to be a xerophytic modification such as is met with in recent Conifers.

The specialization of the tissues indeed is only such as is quite in keeping with the xerophytic nature of marsh plants. Moreover, the particular group of Equisetales are quite typical of fresh water, and we should expect that if their ancestors had been Halophytes, some, at any rate, at the present day would have retained this mode of life. Nor have we at the present time any halophytic Lycopodiales, while *Isoëtes*, the nearest relative to the *Lepidodendra*, is an aquatic or sub-aquatic form associated with fresh water.

Among the Filicales, *Acrostichum aureum* seems to be the only halophytic form, inhabiting as it does the swamps of the Ceylon littoral,[9] and though, as Miss Thomas has pointed out, its root structure is in close agreement with that of many paleozoic plants, its frond shows considerable deviation from that of *Lyginodendron* or *Medullosa*, both of which plants, as

[9] Tansley, A. G., and Fritsch, "The Flora of the Ceylon Littoral," *New Phytologist*, Vol. IV., 1905.

Pteridosperms, are on a higher plane of evolution, and might therefore be expected to show a more highly differentiated type of leaf. But on the contrary these coal-measure plants show a more typically Filicinean character, both as regards the finely dissected lamina and also in the more delicate texture of the foliage compared with the specialized organization of the frond of *Acrostichum aureum,* described by Miss Thomas.

Nor is it necessary to call to aid the salinity of the marsh to explain the excellent preservation of the tissues of the plant-remains in the so-called coal-balls, in view of the well-known power of humic compounds to retard the decay of vegetable tissues. In addition to these arguments, I might draw attention to the presence of certain fungi among the petrified débris, as more likely to be found in fresh water than in marine conditions. *Peronosporites,* so common in the decaying Lepidodendroid wood, and the *Urophlyctis*-like parasite of Stigmarian rootlets, seem to me to support the fresh-water nature of the swamp; just as the occurrence of the mycorhiza, described by Osborn, in the roots of *Cordaites* seems to indicate the presence of a peaty substratum for the growth of that plant. Potonié also refers to the occasional occurrence of Myriapoda and fresh-water shells as indicative of the fresh-water origin of at least many of the coal deposits, and a common feature of the petrified remains of coal-measure plants is the occurrence of the excrements of some wood-boring larvæ in the passages tunneled by these paleozoic organisms through the wood of various stems.

A strong argument in favor of the brackish nature of these swamps would be supplied by the definite identification of *Traquairia* or *Sporocarpon* as Radiolaria, though we must remember that certain marine Cœlenterata find their way up into the Norfolk Broads, the fresh-water Medusæ are by no means unknown in different parts of the tropics. Of course, if the coal-measure swamps were estuarine or originated in fresh-water lagoons near the sea, they may have been liable from time to time to invasions of salt water, sufficient to account for the presence of occasional marine animals, but without constituting a halophytic plant association.

Potonié, who has made so close a study of the formation of coal, and who supports the theory of its fresh-water origin, considered for a long time the comparison between the coal-measure swamp and the cypress swamps of North America, as the nearest but at the same time a somewhat remote analogy, more particularly as he believed that the nature of the coal-measure vegetation required a tropical and also a moister climate than obtains in the southern states of North America. Though, in view of the great development of Pteridophytic vegetation in countries like New Zealand, I think Potonié possibly exaggerates the temperature factor, he is probably right in assuming a fairly warm climate for the coal-measure forest. The difficulty, so far, has been to account for the great thickness of humic or peaty deposits which must have accumulated for the formation of our coal-seams, in view of the fact that extensive peat formation is generally associated with a low temperature. In the tropics, peat may be deposited at high altitudes, where there is low temperature and high rainfall, but it is generally supposed that the rate of decomposition of vegetable remains is so active that lowland peat-formation was out of the question. Dr. Koorders, however, has observed a peat-producing forest in the extensive plain on the east side of Sumatra, about a hundred miles from the coast. This swamp-forest

has been recently reexplored at the instance of Professor Potonié, and he finds it to agree closely with the vegetative peculiarities which he considers must have been presented by the vegetation of the coal-measure forest. A typical "Sumpflachmoor," this highly interesting tropical swamp has produced a deposit of peat amounting in some places to thirty feet in thickness. The peat itself consists mainly of the remains of the Angiospermic vegetation of which the forest is made up, including pollen-grains and occasional fungal filaments; the preservative power, which has enabled this accumulation of débris to take place, being due to the peaty water which is seen above the roots of the bulk of the vegetation. The latter consists mainly of dicotyledonous trees belonging to various natural orders, and they mostly show such special adaptations as breathing roots (pneumatophores) and often buttress roots. With the exception of a tree-fern, Pteridophyta, Liverworts and Mosses, and, indeed, all herbaceous vegetation, are poorly represented in this swamp, though high up in the branches of the trees there are a fair number of epiphytes, and at the edge of the swamp-forest lianes, belonging particularly to the palms, play an important part in the vegetation. The water, partly on account of its peaty nature, partly owing to the intense shade, is almost devoid of algæ, and none of these organisms were found in the peat itself. The interesting account given by Potonié of this tropical peat-formation is very suggestive when certain features, as, for example, the absence or relative paucity of certain of the lower groups of plants, such as algæ and Bryophyta, in the peat, are compared with the plant-remains in some of our coal-seams. Replacing the now dominant Angiosperms by their Pteridophytic representatives in paleozoic times, we have a very close parallel in the two formations.

Another interesting question arises when we consider the great variety of types of vegetation met with among the plant-remains of the coal-seams. For in addition to the limnophilous *Calamites* and Lepidodendraceæ mentioned above, the coal-balls abound with the remains of representatives of the Filicales, the Pteridospermæ and the Cordaitaceæ. Were these also members of this swamp vegetation, or have their remains been carried by wind or water from surrounding areas? With regard to some plant-remains, namely, those found exclusively in the roof nodules, the latter was undoubtedly the case; for we have ample evidence, both in their preservation and their mode of occurrence, that they have drifted into the region of the coal-measure swamp after its submergence below the sea. This would apply to such plants as *Tubicaulis Sutcliffii* (Stopes), *Sutcliffa insignis* (Scott), *Cycadoxylon robustum* and *Poroxylon Sutcliffii* and other forms, the remains of which have so far not been observed in the coal-seam itself. These plants represent a vegetation of non-aquatic type, and may be taken to have grown on the land areas surrounding the paleozoic swamps. But, on the other hand, we have remains of many non-aquatic plants in the coal-seam itself, closely associated with fragments of typical marsh-plants. How can their juxtaposition be explained?

The advance of our knowledge of ecology points, I think, to a solution of this difficulty. No feature of this fascinating study, which has of late gained so prominent a place in botanical investigation, is more interesting than to trace out the succession of plant associations within the same area, noting the ever-changing conditions which the development of each as-

sociation brings about. If we follow with Schroeter the gradual development of a lacustrine vegetation from the reed-swamp through the marsh (or Flachmoor) to a peat-moor (Hochmoor), we see how one plant association makes place in its turn for another. May not the mixture of various types of vegetation which we meet with in the petrifactions of our coal-seam represent the transition from the open Calamitean or Lepidodendroid swamp to a fen or marsh with plentiful peat-formation, due to the gradual filling up of the stagnant water with plant-remains? Thus in places, at any rate, a transition from aquatic to more terrestrial types of vegetation would take place, while the tree-like forms rooted in the deeper water would continue to flourish. The coal-measure swamp in this stage would differ from the tropical swamp of Kooders by a more abundant undergrowth of herbaceous and climbing plants, rooted in damp humus and passing off gradually into drier peat. Such an undergrowth of Cryptogamic types, mainly Filicinean or Pteridospermic, would have admirable conditions for luxuriant development, apart from the provision of a suitable substratum for its roots, owing to the narrow xerophytic nature of the foliage on the canopy of the trees under which it grew.

Here, too, we see the explanation of the striking difference between the microphyllous and arborescent *Calamites* and Lepidodendraceæ, and the large ombrophile foliage of the Filicineæ and Pteridosperms, which spread out their shade-leaves under the cover of marsh xerophytes, in exactly the same way as Professor Yapp has so admirably depicted for recent plants in his account of the "Stratification in the Vegetation of a Marsh."

The development of a mesophytic vegetation in the shelter of the marsh xerophytes makes it unnecessary to postulate an obscuration of the intense sunlight by vapors, as was done by Unger and Saporta for the Carboniferous period. The assumption of a variety of conditions of plant life within the same area helps materially to clear up the difficulties presented by the somewhat incongruous occurrences met with in the petrified plant-remains. The presence of fragments of *Cordaites,* mixed with those of *Calamites* and *Lepidodendra,* in the coal-balls can not always be explained either by a drift theory, or by conceiving the fragments to be wind-borne; but, given an area of retrogressive peat above the ordinary water-level, and even so xerophytic a plant as *Cordaites* might well establish itself there, its mycorhiza-containing roots being well adapted for growth in drier peat. The curious occurrence of more or less concentric rings in the secondary wood of the stem and roots of *Cordaites* may represent a response probably not to annual variations of climate, but to abnormal periods of drought, which would affect the upper-peat layers, but not the water-logged soil in which were rooted the *Calamites* and *Lepidodendra.*

If, as I suspect, we had in the peat deposit of the coal-seam a succession of associations, we ought to find its growth and history recorded by the sequence of the plant-remains, very much as Mr. Lewis has discovered with such signal success in our Scottish peat-bogs. That some differences occur in the plant-remains building up a seam can be noted by a microscopic examination of the coal itself, in which, as Mr. Lomax tells me, the spores of *Lepidodendra* occur in definite bands. But no systematic attempt has as yet been made to investigate from this point of view the seams charged with petrified plant débris. Before the Shore pit, which was reopened last

summer through the renewed generosity of Mr. Sutcliffe, was finally closed down, I obtained two series of nodules, ranging from the floor to the roof of the seam, and have had these cut for detailed examination. I should not, however, like to make any generalizations from these isolated series, but intend, during the coming winter, to investigate in the same manner further series taken from large blocks of nodules, which have been removed bodily so as to retain the position they occupied in the seam. Though at present the data are only fragmentary, there seems to be some indication that the plant-remains are not without some relation to their position in the seam. Of course, Stigmarian rootlets are ubiquitous, and in the nodules of the lower part of the seam predominant, but other plant-remains appear to be more frequently found at one level of the seam than another. The problem, however, is very involved, and it has become apparent that it is as important to study the fine débris in which the larger fragments are embedded as the distribution of these latter. Moreover, attention must be paid to the stage of decomposition presented by the particles forming the matrix of the nodule, as this varies in the lower and upper parts of a seam, very much as in a peat-bed we can distinguish the lighter-colored fibrous peat from the darker layers at the base of a peat-cutting. Mr. Lomax, who has so unique an experience of these coal-balls, informs me that he can tell whether a nodule is from the top or bottom of the seam by the lighter or darker color of the matrix. The importance of applying the methods which have been so successful in elucidating the history of modern peat-deposits to the investigation of the coal-seam will be clearly appreciated both by paleobotanists and ecologists, and this particular problem offers a striking illustration of the interdependence of various branches of botanical investigation. It is fortunate indeed that the two fields of work, paleobotany and plant ecology, though they have been subjected to fairly intensive cultivation, have not become exclusively the domain of specialists. The strength and progress of modern botany have been due to the close collaboration of workers engaged in different branches of botanical science, and the fact that British ecologists have combined to attack a series of the problems from very diverse points of view leads one to hope that, with a continuance of that intimate cooperation which has characterized their work so far, and with the added stimulus of the friendly visit of our distinguished colleagues from abroad, considerable progress may be expected in the future in this branch of botanical study. Privileged as I have been to assist at the deliberations of the British ecologists, without as yet having taken any active part in their work, I feel myself at liberty to point with appreciation to the excellent beginning they have made of a botanical survey of Great Britain and Ireland, as well as to the more detailed investigations of special associations and formations, such as the woodlands, the moorlands, the fens, the broads, salt marshes and shingle beaches. I am glad to think that our foreign visitors have been able to see these interesting types of vegetation under the guidance of those who have made a special study of these subjects.

The importance to ecologists of an up-to-date critical flora was dwelt upon by my predecessor in this presidential chair, and this obvious need may be regarded as a further illustration of the interrelationship of the various aspects of botanical science. Though it has been obvious to all that the swing of the pendulum has been for a long time away from pure systematic

botany, I am convinced that the great development of plant ecology, of which we have many indications, will not merely lessen the momentum of the swinging pendulum, but will draw the latter back towards a renewed and critical study of the British flora. That a revival of interest in systematic botany will come through the labors of those who are engaged in survey work and other forms of ecological study, is foreshadowed by the fact that Dr. Moss has undertaken to edit a "New British Flora," which will, I believe, largely fulfill the objects put forward by Professor Trail in his presidential address. I trust, however, that in addition to the ecologists, those botanists who are interested in genetics will contribute their share towards the completion of our knowledge of critical species, varieties and hybrids, all of which offer such intricate problems alike to the systematist and to the student of genetics.

De Vries prefaced his lectures on "Species and Varieties, their Origin by Mutation," by the pregnant sentence: "The origin of species is an object of experimental investigation," and this is equally true of the study of the real and presumptive hybrids of our British flora, which may be investigated either synthetically or, when fertile, also analytically, as in some cases their offspring show striking Mendelian segregation. Some good work has already been accomplished in this direction, but more remains to be done, and we have here an important and useful sphere of work for the energies of many skilled plant-breeders.

I would, therefore, like to plead for intimate collaboration between all botanists, hopeful that, as progress in the past has come through the labors of men of wide sympathies, so in the future, when studies are bound to become more specialized, there will be no narrowing of interests, but that the various problems which have to be solved will be attacked from all points of view, the morphological, the physiological, the ecological and the systematic. Thus by united efforts and close cooperation of botanists of all schools and of all countries we shall gain the power to surmount the difficulties with which our science is still confronted.

F. E. Weiss

WORK AT THE MARINE BIOLOGICAL STATION OF SAN DIEGO DURING THE SUMMER OF 1911

Because a majority of the station's staff are still holding college positions and hence can be at La Jolla only during vacation time, the summer months are the most active of the year. This disadvantage must continue until the income is sufficient to maintain operations at sea and a considerable part of the work in the laboratory throughout the year.

On the biological side the most important event of the year is the final issuance of Mr. E. L. Michael's "Classification and Vertical Distribution of the Chætognatha of the San Diego Region" (Univ. Calif. Public. Zoology, Vol. 8, No. 3, 165 pp.). In this the author not only records all the species so far taken in these waters and subjects the description and taxonomy of the group to a critical examination, but deals quantitatively with the large amount of data collected during the five years from 1904 to 1909.

The aim of the ecological aspect of the investigation was to ascertain the facts concerning the distribution, seasonal and vertical, of the organisms, and to see how far these are correlatable with and hence dependent upon the environmental factors of light, and of temperature and density of the water. Efforts were limited to these three environmental factors simply because the scope of the station's work up to this time has not made it possible to extend the hydrographic observations beyond these.

While it is impossible to summarize here

the results reached, a few, particularly significant, may be indicated.

Comparison of the distribution of the ten species occurring in the area "shows conclusively that the manner of distribution is correlated with the organization of the species. In other words, the distinctive manner in which each species is distributed is as much a *specific character* as is its structure." For example, each species appears to have its own depth of maximum abundance, spoken of by Mr. Michael as its "center of migration." This is certainly true of the more abundant species, and seems to be true of those which do not occur in sufficient numbers to render the results so far obtained entirely conclusive. From 15 to 20 fathoms is found to be the center of migration of *Sagitta bipunctata*, the most abundant species, while between 100 and 200 fathoms is the center for *S. serratodentata*. These results strengthen the growing idea of species characters in the habits of organisms, and so are of considerable general importance.

The correlations of distribution with temperature and also with density, which are distinctly indicated if not fully proved, are, in several ways, rather unexpected and surprising, particularly as regards density correlations. If these results are borne out by further observations they will still further emphasize the complexity of *orderly interrelations* that prevail between organic beings and their surroundings.

Professor Kofoid has this summer published numbers IV. and V. of "Dinoflagellata of the San Diego Region" (Univ. of Calif. Publ. Zoology, Vol. 8, Nos. 4 to 6, 106 pp.). By far the more extensive of these is No. 4 dealing exclusively with *Gonyaulax*.

It is hardly to be supposed that all the species occurring in the area have now been recorded. Nevertheless, the author has felt his experience with the group to be extensive enough to justify him in giving the genus a thorough overhauling. This he has done largely on the basis of local material but also partly on that of collections from other parts of the world. Of the 25 species recognized as belonging to the revised genus 14 are recorded from the San Diego region, four of which are new. One species formerly included in Gonyaulax, *G. jollifer*, has been made the basis of a new genus, *Spiraulax*.

The author is, warrantably it seems, particularly impressed with "the all-pervading character of specific differences in both morphological and physiological details" among these organisms.

Special attention is given to *G. polyedra*, the species chiefly responsible for the "red-water" and wonderful display of phosphorescence that occurs in this region at times.

It would appear that Professor Kofoid is well ready for the next steps—study of the distribution, reactions, propagation, etc., of these organisms.

Dr. C. O. Esterly, who up to this time has been able to do little more than describe and record the great number of species of copepods of the region, has now taken seriously in hand the problems of seasonal and vertical distribution in this group. The summer has enabled him to advance the task well beyond the points indicated by his two recent papers, "The Vertical Distribution of *Eucalanus elongatus* in the San Diego Region during 1909" (Univ. Calif. Public Zoology, Vol. 8, No. 1) and "Diurnal Migration of *Calanus finmarchicus* in the San Diego Region during 1909" (*Intern. Rev. d. ges. Hydrobiol. u. Hydrogr.*, Bd. 4).

Treatment of the data relative to the distribution of some of the species of *Salpa* is now under way by Mr. Michael and the Director and it is hoped that a report on this group may be ready some time during the winter.

In order to extend the migrational studies, on the one hand, to animals better endowed than the groups already treated, with the powers of vision and locomotion, and, on the other hand, to those less well provided with organs of light perception and locomotion, it is proposed to take up, as soon as possible, the schizopoda and the ctenophora.

Now that considerable headway has been made in investigating the distribution and

movements of pelagic animals as they occur in nature, the desirability of subjecting the same groups to laboratory experimentation is more obvious than ever. This aspect of the investigations can not be entered upon advantageously until the salt water supply system for the laboratory and landing facilities for boats shall have been completed. A large expenditure of money will be needed for these extensions, but vigorous efforts will be made to accomplish the work within the next twelve or eighteen months.

Although the hydrographic investigations by the station are held to be primarily in the interest of biological problems, at the present moment some of the results being reached are of themselves so important as to make them closely rival in interest the biological work itself. Dr. G. F. McEwen, who has charge of this side of the researches, has devoted himself almost entirely, during this and the preceding summer, to testing V. W. Ekman's theory of oceanic circulation so far as it applies to the phenomena of upwelling waters along the continental margins of the great oceans. The study has gone far enough to make it clear that radical modification will have to be made of the widely held supposition that the low summer temperature of the sea along the west coast of North America south of Point Conception, is due to a "California branch of the Japan Current." Just how far this modification will have to go can not be determined without extending the temperature observations much farther to sea, and as far south as the extremity of Lower California at least.

A particularly interesting point in connection with Ekman's theory is the relation which it assumes to exist between water temerature at the surface, as well as at different depths, and bottom topography. In a region like that in which we are operating, where there is a large area of continental shelf presenting numerous islands, banks, deep valleys and channels, that is, of varied bottom configuration, this element is specially important, not only in itself, but probably in its bearing on the distribution of pelagic organisms.

Mr. W. C. Burbridge, of Stanford University, who for the last two years has had in hand most of the laboratory work on water samples, has been more successful this summer than before in manipulating the rather complicated Fox apparatus for determining the gaseous content of the water. A large number of determinations were made, but the data have not yet been worked up, so it is impossible to say how valuable they are. The impression gained is that the method, even with its obvious and necessary limitations, will give results that can be safely and significantly used as one more factor in studying the environmental conditions of pelagic organisms.

During the summer the Station has entered into relations with the California State Game and Fish Commission for the economic study of the "spiny lobster" (*Palinurus interruptus*); and with the Bureau of Soils of the United States Department of Agriculture for estimating the quantity of "kelp" (*Macrocystis pirifera* and *Nereocystis Luetkeana*) on the coast south of Point Conception for such industrial purposes as these plants may be turned to.

Dr. B. M. Allen, of the University of Wisconsin, has charge of the former work, and his searching inquiry into the lobster fishery as it is now prosecuted not only on the California but also on the Mexican coast, has already brought to light various facts which, if followed up, should aid materially in formulating legislation for the preservation of this industry.

The work for the Bureau of Soils is in the hands of Mr. W. C. Crandall, now acting in the three-fold capacity of teacher of biology in the State Normal School at San Diego, secretary of the Marine Biological Association, and captain of the station's scientific boat, the *Alexander Agassiz*.

These industrial undertakings are, at present, aside from the main aims of the station. This, however, is in no wise due to lack of sympathy on the part of the chief patrons and the officials of the Biological Association with such undertakings, but entirely to the

circumstance that, under the present limitations of income, it seems wisest to make research the primary object. Consequently, whenever, as in these cases, it happens that equipment and experience can be made to serve industrial ends without considerable interference with research, the management is more than glad to thus extend the station's usefulness.

Worthy of record is the solution that has been reached, so far as the work itself is concerned, of the problem of manning the *Agassiz* satisfactorily to the purposes for which she exists. Considerable difficulty has been experienced heretofore in finding a man who should be at the same time seaman and scientist enough to get the best results from the operations at sea. Mr. Crandall, when not occupied in the school room, had spent much of his time on the boat looking after the scientific work. He finally decided that with a little more preparation he could manage the whole business, boat and all, more satisfactorily than it was being done. Consequently, he successfully took the examination for a license as master of a boat of the class to which the *Agassiz* belongs. The result is that the boat, under his command, is being operated more efficiently, smoothly and economically in proportion to the work done than ever before. The one serious difficulty is, of course, that school duties make it impossible for him to go with the boat at times when it is very important for her to be at sea.

Although in a number of respects conditions at present are such as to make it impossible to specially encourage outside investigators to come to the station for the prosecution of their special studies, still several who were willing to take their chances of finding enough to make the coming worth their while have been at La Jolla during the summer.

Dr. David Marine, of the medical research laboratories of the Western Reserve University, devoted six weeks to studying the endostyle of the lower chordates. His aim is to apply chemical and physiological tests to this structure for the purpose of finding whether any of the reactions characteristic of the thyroid of man and the higher chordates, can be detected. It was not possible in so short a time to carry the work to definite results, positive or negative. It is certainly to be hoped that Dr. Marine may be able before long to push the study to a conclusion.

Professor H. B. Ward, of the University of Illinois, with three graduate students, spent about six weeks at the station on the very laudable mission of gaining a knowledge of the marine fauna and general biological conditions of the region. Incidentally Dr. Ward gave two popular lectures to appreciative audiences of La Jolla citizens, one on "Zoology in Relation to Human Welfare," and the other on "Public Health."

WM. E. RITTER

LA JOLLA, CAL.,
October 3, 1911

THE INTERNATIONAL EUGENICS CONGRESS

THE Eugenics Education Society has arranged for an International Eugenics Congress to be held in London from July 24 to 30, 1912, under the presidency of Major Leonard Darwin. It is proposed to group the papers into the following four sections:

1. *The Bearing upon Eugenics of Biological Research.* Facts of Heredity; Physiological Aspects of Heredity; Variations, their Nature and Causation; Race Mixture.
2. *The Bearing upon Eugenics of Sociological and Historical Research.* Historical Evidence with regard to changes in Racial Characters; Birth-rate and Death-rate Statistics; Effects of Medical and Surgical Treatment in Encouraging Unfitness.
3. *The Bearing upon Eugenics of Legislation and Social Customs.* Marriage Laws and Customs; Taxation; Economic Conditions; Insurance; Trades Unionism.
4. *Consideration of the Practical Applications of Eugenic Principles.* Prevention of the Propagation of the Unfit by Segregation and Sterilization; Voluntary Restriction of Propagation of the Unsound; The Encouragement of the Propagation of the Fit; Promulgation of the Eugenic Ideal; The Place of Eugenics in Educational Systems.

PROFESSOR JOHANNSEN'S COLUMBIA LECTURES

PROFESSOR JOHANNSEN's lectures on the modern principles of heredity at Columbia University, briefly announced in a previous issue of SCIENCE, will deal with the following topics:

October 13—"The Problem of Personal Characters." Old Conceptions of Heredity; Transmission of Personal Characters; Variation and Phenotypes; Selection; Galton's Law of Regression; The Study of Pure Lines; Explanation of Galton's Regression; Criticisms of the Transmission Conception; The Genotype Conception; Personal Characters Irrelevant; Constancy of Genotypical Elements; Modern Definition of Heredity.

October 20—"The Problem of Unit Factors." Homozygotes and Heterozygotes; Hybridization; Mendelism; Segregation and Combination of Genotypical Elements; Genetic Constructions; Personal Characters as Reactions of Genotypical Elements; Complicated Cases.

October 27—"Problems of Correlation and Sex." Exceptions to Mendelian Behavior; Blending Characters; Repulsion and Coupling of Genotypical Elements; Sex-limited Inheritance; Cytological Questions.

November 3—"The Problem of New Biotypes." Mutations; External Factors acting upon Genotypical Elements; Mutations and Mendelism; Acquired Personal Characters; Criticisms of Lamarckian Views; Facts and Speculations; Morphological Views *versus* Chemical Views in Genetics; Summary.

These lectures are given under the auspices of the departments of botany and zoology and will constitute the twelfth series of Columbia biological lectures. They will be given in Room 305, Schermerhorn Hall, at 4:10 P.M., and are open to the public.

SCIENTIFIC NOTES AND NEWS

BY invitation of the trustees of the New York Public Library the autumn meeting of the National Academy of Sciences will be held in its new building, Forty-second Street and Fifth Avenue, beginning on Tuesday, November 21. The first business meeting of the academy will be held on Tuesday morning at eleven o'clock and the first open scientific session will be at two o'clock in the afternoon. Titles of papers should be sent to Dr. John S. Billings, secretary of the local committee, New York Public Library.

OWING to the epidemic of cholera, the various international congresses, geographical, agriculture and tuberculosis, will not meet in Rome this autumn. They have been postponed until the spring of 1912, the exact date not yet being determined.

AMONG the degrees given by the University of Vermont on the occasion of the installation of President G. P. Benton were doctorates of laws on Dr. Henry S. Pritchett, president of the Carnegie Foundation; Dr. E. F. Nichols, president of Dartmouth College, and Dr. Harvey W. Wiley, chief of the Bureau of Chemistry.

PROFESSOR A. A. MICHELSON, head of the department of physics, at the University of Chicago, has returned from the University of Göttingen, where he has been exchange professor during the summer semester.

DR. C. WILLARD HAYES, chief geologist of the U. S. Geological Survey, has retired to engage in technological work in Mexico.

DR. EDWARD RENOUF, collegiate professor of chemistry at the Johns Hopkins University since 1890, has retired from active service.

DR. FRANZ MERTENS, professor of mathematics at Vienna, has retired from the active duties of his chair.

ASSOCIATES of the Harvard University Museum for five years from September 1, 1911, have been appointed as follows: Robert Tracy Jackson, S.D. (paleontology); Frank Springer, Ph.B. (paleontology); Frank Shipley Collins, A.M. (botany); Edward Phelps Allis, Jr., LL.D. (zoology); Arthur Cleveland Bent, A.B. (ornithology); William Barnes, S.B., M.D. (entomology); Frederick Blanchard (entomology); Andrew Gray Weeks, A.B. (entomology).

DR. L. R. GEISSLER, of Cornell University, has been appointed associate psychologist in the physical laboratory of the National Electric Lamp Association, Cleveland, O.

PROFESSOR LUIGI CARNERA, director of the International Latitude Stations at Carloforte and Oncativo, has been appointed professor of

astronomy and geodesy in the Instituto Idografico della R. Marina at Genoa.

DR. EMIL HEINRICHER, professor of botany at Innsbruck, has been elected a corresponding member of the Vienna Academy of Sciences.

DR. RICHARD C. MACLAURIN, president of the Massachusetts Institute of Technology; Professor Arthur A. Noyes, of the department of chemistry; Professor Charles R. Cross, of the department of physics; Professor C. M. Spofford, of the department of civil engineering; Professor C. H. Peabody, of the department of naval architecture, and Professor Dougald C. Jackson, of the department of electrical engineering, have returned from visits made abroad during the present summer to inspect foreign schools of technology and laboratories, in view of the new buildings to be erected by the Massachusetts Institute of Technology.

WE learn from the *Journal* of the American Medical Association that the New York Post-Graduate Medical School and Hospital is preparing to send out an expedition next spring for the purpose of studying tropical diseases. A special fund of $15,000 for this purpose has been given by Col. Robert M. Thompson, of New York, and John H. McFadden, of Philadelphia. Capt. Joseph F. Siler, M.C., U. S. A., lecturer on tropical diseases, will have charge of the expedition.

PROFESSOR A. W. JOHNSTON, of the department of geology of the University of Minnesota, spent the summer in a section of northern British Columbia within the arctic circle heretofore unexplored.

PROFESSOR EDWARD LEE HANCOCK, professor of applied mechanics in the Worcester Polytechnic Institute, died on October 1, at the age of thirty-eight years.

THE Rev. Mariam Balcells, member of the Jesuit order, professor of mathematics at Boston College for the past two years, previously director of the department of solar physics at the Observatorio del Ebro, Tortosa, Spain, died on October 2, at the age of forty-seven years.

DR. N. V. USSING, professor of mineralogy in the University of Copenhagen, has died at the age of forty-seven years.

M. GIROD, professor of botany at the University of Claremont, has died at the age of fifty-six years.

THE death is also announced of Dr. Karl Waitz, professor of physics and astronomy at Tübingen.

THE Bureau of Mines will hold a national mine safety demonstration at Pittsburgh on October 30 and 31. The program is as follows:

October 30—9:00 A.M. to 12:00 M.: Demonstration and explosions; exhibit of explosives, safety lamps, fuel testing, etc., at the Bureau of Mines buildings, in the Arsenal Grounds, Fortieth and Butler Streets, Pittsburgh, Pa. 2:30 P.M. to 5:00 P.M.: Demonstrations and explosions in the Bureau of Mines Experimental Mine near Bruceton, ten miles south of Pittsburgh, Pa., reached by Baltimore and Ohio R. R. train, leaving Pittsburgh at 2:00 P.M., eastern time.

October 31—9:00 A.M. to 10:30 A.M.: First aid exhibit. 10:30 A.M. to 11:30 A.M.: Explosion, rescue work and mine gas. 11:30 A.M. to 12:00 M.: Presentation of prizes by President Taft. 12:30 P.M.: Luncheon to President Taft at the Hotel Schenley. 2:00 P.M. to 5:00 P.M.: President Taft will review river pageant. 7:30 P.M.: Dinner to President Taft at the Hotel Schenley.

A REUTER message from Adelaide states that Mr. Brown, the South Australian government geologist, reports that the uranium ores recently discovered in the northern portion of South Australia possess great importance.

THE world's production of quicksilver last year was 3,747 short tons, of which the United States produced 773 short tons. Quicksilver is usually quoted in "flasks," a flask containing 75 pounds. The American production therefore represents 20,601 flasks. Of this amount California furnished 17,211 flasks. In 1850 the quicksilver production of that state was 7,723 flasks, but California's greatest production was in 1881, when the yield was 60,851 flasks. In 1910 only two countries produced more quicksilver than the United States —Italy 882 tons and Spain 1,102 tons. These

and other statistics are given in an advance chapter on quicksilver from "Mineral Resources of the United States," 1910, by H. D. McCaskey, of the United States Geological Survey.

DURING the past few years various expeditions from the University of Chicago have secured from the fossil fields of northern Texas the largest and best collection of Permian vertebrate fossils in the world. The past summer an expedition from the university, under the direction of Professor S. W. Williston, has explored the Permian deposits of northwestern New Mexico with valuable results. These Permian deposits, of small extent, in Rio Arriba County, were discoverd more than thirty years ago, but have been neglected by explorers ever since, and their precise location even was unknown to geologists. As a result of Professor Williston's excavations, numerous fossils have been shipped to the university, many of which are unknown to science. This collection includes six or seven new genera of reptiles and amphibians, one of which is represented by one of the most perfect skeletons, about six feet in length, ever found in any deposit in America. This skeleton will be mounted in Walker Museum the coming year by Mr. Paul Miller, who collected its parts. The scientific results of the expedition will shortly be published in detail.

A CONFERENCE of the International Aviation Map Commission took place recently in Brussels under the presidency of Prince Roland Bonaparte. In the proceedings of the conference as reported in the *British Geographical Journal,* a distinction was made between questions ripe for discussion and those of a more problematical character; definitely formulated votes being adopted only in the case of the former. They arose for the most part directly out of the discussions of the conference, while the more theoretical matters were the subject of lectures by specialists. The recommendations adopted had to do with (1) scale; (2) subdivision of the map and boundaries of the several sheets; (3) the numbering and naming of the sheets; (4) the orthography of geographical names. An important decision was reached in the adoption of the scale of 1:200,000, while it was also agreed that the separate sheets should each embrace the field of one degree. The initial meridian to be that of Greenwich, the descriptive text in the language of the nation concerned. A single sheet of the International millionth map would correspond to 25 sheets of the new aviation map, but considerable objection was made to the employment of the former for the purpose of giving a general view of the area in question. As regards the method of representing the surface, the only recommendation that found acceptance (out of some twenty-five different suggestions) was that on the occasion of the next great overland aviation contest, a variety of such systems might with advantage be tested. Exception was taken by the English representative to overloading the map with conventional signs in red; stress was, however, laid on the desirability of a uniform representation of electrical power stations by series of red crosses. The question of the representation of relief was also held to be not yet ripe for decision. On this subject a paper was read by Dr. K. Peucker, one of the Austrian representatives, who insisted on the need of a special method of representation fitted to bring out visibly to the eye the extent of the difference in altitude, so that the aviator might be able to grasp the exact measure of the obstacles to free progression. In accordance with this view, it has been decided by the German Association of Aviators to construct a specimen-map of a portion of the Rhine basin on the color-plastic system. The recommendations of the conference, as also the results of experiments in the desired directions, are to be laid before the International Aviation Congress at Rome in October. Special mention should be made of an address by Professor Berget before a general meeting of the Belgian Aero Club on the subject of topography and aeronautics. The lecturer brought out on the one hand the reasons which lead aeronauts to make a new claim on cartography, and on the other, the extent to which aviation may help to raise cartography to a higher level.

OVER $3,000,000 worth of abrasive materials were produced in the United States last year. All branches of the abrasive industry showed notable growth except the millstone and the grindstone industries, according to W. C. Phalen, of the United States Geological Survey, in an advance chapter from Mineral Resources of the United States, 1910. The total estimated value of all the abrasive materials consumed in this country last year was $4,234,662, of which $3,010,835 worth were of domestic production. Abrasive materials may be divided into two classes—natural and artificial. The production of artificial abrasives has shown great increase since they were first made, less than 15 years ago, and at the present time it exceeds that of the natural abrasives. During 1910 natural abrasives valued at $1,406,805 were produced in 21 states. Of these materials, grindstones and pulp stones led with a production valued at $796,294. The production of burrstones and millstones in the United States in 1910 was valued at $28,217. The production of oilstones and scythe stones amounted to $228,694, compared with $214,019 in 1909. Garnet is one of the very hard minerals, and is extensively used as an abrasive. The production of abrasive garnet in 1910 amounted to 3,814 short tons, valued at $113,574. This was an increase of 842 tons, or 28 per cent., in quantity, and of $11,259, or 11 per cent., in value. In the class of artificial abrasives are included carborundum, alundum and crushed steel. The production of artificial abrasives in 1910 showed an increase of 2,559,000 pounds in quantity and of $238,210 in value, as compared with 1909.

UNIVERSITY AND EDUCATIONAL NEWS

THE class of 1886 has presented to Harvard University $100,000, the income of which is to be used for the benefit of the college. From Mr. William J. Riley, of Boston, the university has received $25,000 for the establishment of scholarships in memory of his nephew Clemen Harlow Condell.

DR. GUY POTTER BENTON was installed as president of the University of Vermont on October 6. In the morning there were addresses from representatives of various institutions; in the afternoon the governor of Vermont administered the oath of office and Dr. Benton gave the inaugural address. In the evening there was a corporation dinner and on the preceding day an educational conference was held.

MESSRS. J. B. DUKE and B. N. DUKE have made further gifts amounting to $228,000 to Trinity College.

THE installation of Dr. Elmer Ellsworth Brown as chancellor of New York University will take place on Thursday, November 9. Presidents Lowell of Harvard, Hadley of Yale, Butler of Columbia, Schurman of Cornell and Finley of the New York City College will be among the speakers.

PROFESSOR JAMES WILLIAM TOUMEY, who has acted as head of the Yale Forest School during the absence of Professor Graves, has been elected director for the year 1911–12.

WILLIAM H. EMMONS, associate professor of economic geology and mineralogy at the University of Chicago, and geologist for the United States Geological Survey, has been appointed head of the department of geology at the University of Minnesota.

A. C. TROWBRIDGE, instructor in geology at the University of Chicago and assistant geologist of the Illinois Geological Survey, has been appointed professor of geology at the State University of Iowa.

As a result of the resignations of Professor R. A. Harper, Dr. W. G. Marquette, assistant professor, and A. B. Stout, instructor, in the botany department of the University of Wisconsin, who have accepted places at Columbia University, the regents of the state university have appointed E. M. Gilbert, assistant professor of botany; W. N. Steil, E. T. Bartholemew and Alban Stewart, instructors in botany, and A. G. Johnson, assistant in botany.

AT the University of Wisconsin E. Baumgartner has been appointed instructor in anatomy and Assistant Professor Bennett M. Allen

has been transferred from the department of anatomy to that of zoology. New assistants appointed in zoology are H. V. Lacy, Edward H. Jones, Elizabeth A. Smith and Nathan Faster.

DR. ROBERT RETZER, of the University of Minnesota, has been appointed assistant professor of anatomy in the University of Chicago.

A. B. DUNNING, S.B. (Harvard, '07), has been appointed assistant professor of mathematics at Boston University.

AT Northwestern University Leon Irwin Shaw, Ph.D. (Wisconsin), has been appointed instructor in chemistry; George Vest McCauley, Ph.D. (Wisconsin), instructor in physics, and Chester Henry Yeaton, A.M. (Harvard), instructor in mathematics. Robert Harvey Gault, Ph.D., has been advanced from an instructorship to an assistant professorship in psychology and has been appointed editor of the *American Journal of Criminology*.

DISCUSSION AND CORRESPONDENCE

THE COTTON WORM IN MASSACHUSETTS

DURING the last week in September of the present year, a number of moths of the cotton worm, *Alabama argillacea* Hübn., were captured at Amherst, Mass., some of them being taken at night, while others were found at rest during the daytime. Although this insect has been taken at Amherst before, there are no records of it in any such abundance, and it would seem that there must have been quite a pronounced northern migration of this species this season. The moths were very fresh and perfect.

There have been occasional captures of this moth in the New England states, and in the collection of Mrs. C. H. Fernald is a fresh pair taken in September (probably 1881) at Orono, Maine.

It may be well to call attention here to a discussion on the habits of this insect at a meeting of the entomological members of the American Association held in 1882, and reported in *The Canadian Entomologist*, Vol. XIV., p. 151, where some evidence is given, supporting the view that the appearance of this species in the north is not, at least in all cases, due to migration.

H. T. FERNALD

VECTORIAL TREATMENT OF SECONDARY MAXIMA IN GRATING SPECTRA

TO THE EDITOR OF SCIENCE: A friend has been good enough to direct attention to a regrettable error in my review of Wood's "Physical Optics," which appeared in SCIENCE, September 29, 1911.

Instead of alluding to "the author's clever vectorial treatment of secondary maxima in grating spectra," I should have called attention to the fact that the essential features of this beautiful geometrical and graphical method were invented by Professor Arthur L. Kimball. The omission of this fact from Professor Wood's text is doubtless owing to want of space.

I still remember the delight with which I read Professor Kimball's paper when it appeared in the *Philosophical Magazine*, July, 1903, and can explain my forgetfulness and inadvertency only as a consequence of the very considerable amount of sand which has run through my hour glass.

HENRY CREW

QUOTATIONS

THE UNIVERSITY PRESIDENT AND HIS PROFESSORS[1]

A SUCCESSFUL college or university president can not afford, for the sake of his own success, to make his administration in any sense a personal one. It is his business to see to it that the students who commit their training to the institution he serves, are provided with the very best teachers and lecturers the funds at his command will allow him, with the consent of his board of trustees, to give to these young people. If there are instructors whose worth has been demonstrated by years of service, he will put forth every possible effort

[1] Extracts from an address to the senate of the University of Vermont and State Agricultural College by Guy Potter Benton, installed as president on October 6, 1911.

to retain them. The president who has the welfare of his institution at heart will spare no effort to secure the permanency of tenure of those on his teaching staff who are desirable. If here and there he finds a colleague whose work is not satisfactory and can not be made so, he will meet the situation fearlessly in the interests of the young people committed to his care, but he will also meet it with a thoughtful regard for the feelings of the colleague concerned. A resignation is always less painful than a dismissal. It tries the courage of a manly president more to ask, in the spirit of kindness, a resignation than it does in the presence of his board to demand, with heartlessness, a dismissal. The unpleasant responsibility will be courageously accepted by the high-minded man and in a fraternal spirit, the unsatisfactory teacher will be approached by his president months before his connection with the college must be severed with a courteous request for his resignation. An instructor of good sense will appreciate the consideration that prevents a humiliating dismissal, and that affords him ample time, while still under pay, to find another position; and his resignation will be given as requested without disturbance. He who lacks this fine sense of appreciation will still be dealt with in fearless kindness by his president and will not be retained at the expense of institutional efficiency. . . .

If one feature of presidential duty may be emphasized at the expense of another, it will doubtless be agreed that the chief responsibility of a college president is for his educational staff. Before boards of trustees came to a proper comprehension of their limitations, they took official notice of the fitness or unfitness of every member of the faculty, and not only determined the retention or dismissal of incumbent professors and instructors, but solemnly debated the qualifications of all proposed candidates before voting to fill a chair. Their opinion of the worthiness of a professor to continue was formed by the report concerning him coming from immature students or some other incapable informant. As to the election of new faculty members, the board was governed in most instances by flatteringly worded and usually worthless testimonials. To-day it would be difficult to find a trustee presumptuous enough to entertain the thought of passing judgment on the qualifications of teachers. The president is charged with this responsibility and the head of an institution must stand or fall on his ability properly to meet this responsibility. The retention of present members of his faculties and the election of new members in the modern university depends entirely upon the dictum of the president. Those who object to granting such arbitrary power to one man will, on reflection, admit that to hold an executive responsible for all the work of an institution, including the teaching done, would be unfair unless there were guaranteed therewith the privilege of choosing the colleagues for whose work he must answer. In some instances, the president is required by ordinance to nominate new faculty members, the Board confirming or rejecting his nominations, and that is the system which will obtain in this institution from this time forward until it is changed by order of the board of trustees. . . .

The wide-awake president may know of the competency or incompetency of his colleagues by ways more accurate than personal inspection can guarantee. The college community is much more compact than a large public school system. The professors do their work in class-room, lecture-room, laboratory, library and study in buildings on the same grounds and near to each other. The president, when at home, is constantly in their midst and with his hand ever on the college pulse, knows more, or should know more, of what his associates are thinking and accomplishing than the public school superintendent knows of his teachers after all his inspection. The daily intercourse of the president with his coworkers in faculty and committee meetings, in private conferences, and in social relationships, will give to the keen leader of men a knowledge which will enable him to make a fair judgment of individual educational fitness in the day of final reckoning.

The administrative office is a veritable cess-

pool where unpleasant experiences are deposited. All complaints are left there, and if the president, as a spiritual chemist, is skilful in filtering, the residuum will reveal to him the actual substance of all that is justly chargeable against his complained-of colleagues. . . .

No one will question the right of faculty members to advise the president. If he is as wise as such an official should be, he will seek the counsel of his associates and, knowing that "in the multitude of counsellors there is wisdom," he will be ready to modify his plans and policies after hearing from his colleagues. The right to advise, however, does not include within it the prerogative of censorious criticism on the part of the colleagues of the president. Next to a despotic egotist in the presidency, the most obstructive hindrance to the growth of a healthful spirit in a given institution is a coterie of professors, painfully sychophantic in the presence of their "lord and master," and bitterly denunciatory of him when left to themselves. It is difficult to conceive of a more painful caricature on true manhood than that made up of a little professorial group gathered together in a darkened corridor or behind a building gesticulating wildly against the administration, unless it be the same small crowd in the study of one of the number, or in some club-room, planning surreptitiously for the overthrow of their chief.

The president of one of the larger state universities of the central west was apparently highly esteemed by all those who served with him, but when he resigned, one of the prominent professors, too cowardly to be other than obsequious while he thought the tenure of the president permanent, remarked, "Well, there is certainly a great ground-swell of relief among the faculty, now that we are to be relieved from the incubus of this administration." Such reprehensible hypocrisy by those who teach can not but exert a blighting influence upon the life of the institution. . . .

In order that the work of administration might be as efficient as possible, at the recent annual meeting of the board of trustees, I requested the authority to appoint a committee on efficiency, consisting of certain members of the board of trustees and of the teaching body. This privilege was granted. The committee appointed has begun its investigations It is proposed to ascertain, as soon as possible, just how much work each member of the educational staff is doing in the matter of instruction, how much outside work of a public character he is doing for the benefit of the institution, what he is producing in connection with the literature of his chosen line of specialization and—in short—to determine his value to the institution as compared with that of his colleagues. These investigations may result in the conclusion that some men are doing too much work and that others are not doing a sufficient amount. They may lead, as a consequence, at the end of the year to the merging of some positions and to the abolition of certain others. On the other hand, these investigations may lead to a division of work and to the establishment of new positions. A due regard must always be given to the rights of the individual, but the interests of the institution must be made paramount to those of any individual on the educational staff. I feel quite sure that all of you who take the broad and statesmanlike view of educational obligations will agree with the statement just made. No changes could be made now with any degree of intelligence that would command the respect of the college world. The status quo will therefore be maintained for the present. Since, however, a working basis is necessary, some little organization is imperative from the outset and a few important facts must be recognized. . . .

The vulgar swagger assumed by some university and college professors in this latter day would be pitiable if it were not positively mischievous. Time was when the man who taught in college believed that his life should be one of consecration to the highest ideals of character. He believed that all questionable conduct should be avoided. For the sake of his influence upon his students he consistently refrained from indulging himself in those

diversions which to men occupying less responsible positions might be occasionally allowable if not always permissible.

No more hateful spectacle confronts advancing civilization than a beer-sipping, wine-bibbing college or university professor. He is hateful because he is incongruous. More than that, he is hateful because of the havoc he works as an iconoclast in the beautiful temple of youthful ideals. It is a safe prediction in the near coming day when the American saloon is only a historic tradition, that the college professor who drinks in public or in private will not be tolerated beyond the meeting of the board of trustees next succeeding his discovery, and I should say to you in perfect candor at this time, in order that there may be no misunderstanding from the beginning, that I will not serve on a teaching body with any man who uses intoxicating liquors in any form whatsoever. My responsibility to young manhood and womanhood for character ideals is too great to permit me to attempt to bear the burden of responsibility which I could not escape for a colleague who leads an immoral life.

SCIENTIFIC BOOKS

The Mutation Theory. Volume II. The Origin of Varieties by Mutation. By Hugo de Vries. English translation by Professor J. B. Farmer and A. D. Darbishire. Pp. viii + 683. Six colored plates and 149 text-figures. Chicago, The Open Court Publishing Co. 1910.

In May, 1910,[1] the writer had the honor of reviewing Volume I. of the English translation of "Die Mutationstheorie." The inspiration which this volume brought to a large circle of readers made the appearance of volume two doubly welcome. The careful study of the first volume introduced many workers for the first time to the author's own statement of the essentials of the mutation theory, and these essentials, together with a brief summary of de Vries's many important and positive contributions to theoretical and practical biology, through this and his numerous other related writings, were given in the above mentioned review.

[1] *Science*, XXXI., 740–743, 1910.

Of volume two of the translation, Part I. includes Band I., Abschnitt 4, of the original, treating of The Origin of Horticultural Varieties, with chapters on The Significance of Horticultural Varieties in the Theory of Selection, Latent and Semi-latent Characters, The Different Modes of Origin of New Species, The Sudden Appearance of and the Constancy of New Varieties, Atavism, Experimental Observation of the Origin of Varieties, Non-isolable Races, and Nutrition and Selection of Semi-latent Characters.

Part II., The Origin of Eversporting Varieties, includes, from the original, Band II., Abschnitt 2, IV., The Origin of Eversporting Varieties, with four chapters on: I., Tricotylous Races (the title of the German original is "Kreuzung tricotyler Rassen"), omitting § 24 (Kreuzung der Mittletassen mit den Halbrassen) and § 25 (Kreuzung tricolyler Rassen von verschiedenen Arten); II., Syncotylous Races (Kreuzung syncotyler Rassen), omitting § 31 (Kreuzungsversuche); III., The Inconstancy of Fasciated Races (= Band II., Absch. 5, IV.), and IV., Heritable Spiral Torsions (= Band II., Absch. 5, IV.).

Part III. includes Band II., Aschnitt 6, treating of The Relations of the Mutation Theory to other Branches of Inquiry, embracing four chapters: I., The Conception of Species According to the Theory of Mutation; II., The Range of Validity of the Doctrine of Mutation; III., The Material Vehicles of the Heredity Characters; and IV., Geological Periods of Mutation.

Those portions of the original work treating of hybridization (including § 31 mentioned above, and Band II., Abschnitt 1, and Abschnitt 2, I.–III.) have been omitted from the first two volumes of the English translation. Thus the second volume is not merely a translation of volume two of the original. It covers largely the same ground as de Vries's English lectures, published under the title of "Species and Varieties, their Origin by Mutation," but has the advantage of illustrations, which were lacking from "Species and Varieties."

The publication of volume two will help to dispel the erroneous, but still quite prevalent, notion that the theory of mutation is based entirely on observations of the evening-primrose. Even one who has himself carried on experimental pedigreed cultures can not but admire the thoroughness and patience with which thousands of individual plants of scores of different species were examined with minutest care in order to insure adequate grounds for inductive inference, or to secure sufficient data for the confirmation or rejection of a hypothesis. The conception and elaboration of this hypothesis of mutation is the most Darwin-like performance since Darwin, and is, without doubt, one of the most important fruits of Darwin's labors. Like the source of its inspiration (the "Origin of Species"), "Die Mutationstheorie" has given color and direction to all lines of biological inquiry, which will persist for decades to come.

As in volume one, so also throughout volume two, the author keeps close to Darwin's Darwinism, and insists that, far from being intended to supplant the theory of selection, as Darwin held it, the mutation theory is intended merely to complement the other. Thus on page 609: "To Darwin's mind the essential point was . . . that natural selection is a sieve. . . . It creates nothing, as is so often assumed; it only sifts. . . . How the struggle for existence sifts is one question; how that which is sifted arose is another." It is really difficult to conceive how careful readers could ever have confused the issue on this point. Any attempt to restate in this periodical the essence of the mutation-theory would now be out of place.

That phase of de Vries's philosophy which has perhaps met with the greatest opposition is his hypothesis of intracellular pangenesis. It has been rejected as too mechanical and too formal, one author implying that pangens are more "mechanical" than atoms and molecules! This is not the place to discuss the validity of intracellular pangenesis, but it must surely be recognized that as a working hypothesis it has fully justified itself, since it lies at the bottom of all of de Vries's experiments, and of his own explanation of the results. Putting aside the question of its heuristic value, its framer says (p. 643): "for myself pangenesis has always been the starting point of my inquiries; at first only in a theoretical way, but afterwards also for the experimental investigations described in this book. Especially is it this hypothesis which has led me to search for mutations in the field." It is doubtful whether the field observations which led to the classical experiments with Lamarck's evening-primrose and thus to the actual observation of the origin of elementary species, would ever have been made if the hypothesis of intracellular pangenesis had not first taken form in our author's thought (see footnote 3, p. 643, and "Intracellular Pangenesis," English edition, p. 74, footnote).

Whether we accept intracellular pangenesis as an expression of truth or not, and even if we reject it as a working hypothesis, a clear understanding of it is absolutely essential in order to interpret the theory of mutation as it exists in the mind of de Vries. It was largely for this reason that the present writer thought it worth while to translate "Intracellular Pangenesis" into English.

In the language of intracellular pangenesis:

1. Premutation consists in the formation of a new pangen.

2. Progressive mutation consists in premutation, *plus the initial activation of the new pangen.* The result is a new elementary species.

3. Retrogressive mutation is the reverse of progressive mutation; it consists in the return of a pangen from an active to a latent condition. White-flowered varieties are thus caused.

4. Degressive mutation consists in such a transposition of pangens that either (*a*) the more recently activated pangens become semi-latent, being active in rare instances only, thus giving rise to a *half-race* (*e. g.*, wild four-leaved clovers, and other teratological forms); or (*b*) the active pangens become semi-active, giving rise to ever-sporting varieties, middle races (*e. g.*, *Trifolium pratense quinquefolium*

(five-leaved clovers), *Plantago lanceolata ramosa*, and variegated leaves).

"If one of the two parents [in a cross] stands in the relation to the other of having arisen from it by retrogressive or degressive mutation," the progeny, in successive generations, follow Mendel's laws; otherwise they do not, and the result of a cross is then a unisexual, or constant hybrid race. Constant hybrid races correspond to progressive mutations, the Mendelian law to retrogressive and degressive forms of differentiation (pp. 576–577).

But though the mutation theory is a direct outgrowth of the hypothesis of intracellular pangenesis, it fortunately does not stand or fall with the latter, for no scientific theory ever had a firmer foundation in fact—in experimental evidence—than that of mutation.

De Vries claims to have demonstrated experimentally that: (1) "Ordinary or fluctuating variability does not provide material for the origin of new species" (p. 56). While this does not exclude the possibility of different modes of origin of new species, still "Inferences drawn from data after its appearance can hardly be considered as decisive" (p. 56). That is, *the problem is an experimental one.* (2) "The elementary species are demonstrably the existing units of the system; whilst the larger species are only aggregations of these." (3) Elementary species (the theory has nothing to do, except indirectly, with the mode of origin of taxonomic groups) do arise by the method of mutation (discontinuous variation). They have time and again, in a wide variety of sorts, been seen so to arise. No one has ever actually witnessed the origin of a species by any other method.

It is probable that the doctrine of the elementary units of organisms will ultimately prove to be de Vries's most important contribution; though perhaps this doctrine means less to the advancement of philosophical and experimental biology than the firm establishment of the fact, quoted on the fly-leaf of "Species and Varieties," that "The origin of species is an object of experimental investigation." The demonstration of this fact, so conclusively as to compel practically every investigator to acknowledge its truth, is the greatest service rendered to evolutionary biology since Darwin.

On the whole, the translators have performed their work well, though in a few places (*e. g.*, on pp. 608 and 609, cf. German edition, Vol. II., pp. 666), the English can hardly be regarded as a translation of the original. The color plates and the text-figures, notably plate IV., and figures 26, 40 and 54, are quite inferior to those of the German edition. However, it is not easy to find points to criticize adversely, and every one is hoping that an English edition of the now omitted portions, by the same translators, will soon appear.

C. Stuart Gager
The Brooklyn Institute of Arts and Sciences,
Brooklyn Botanic Garden

Outlines of the Theory of Electromagnetism. By Gilbert T. Walker. Cambridge, University Press. 1910.

This volume contains a series of lectures delivered before the Calcutta University on some of the more important developments of electromagnetic theory. The chief novelty of it, compared with other English books on mathematical physics, lies in the consistent use of vector methods, and their advantage is shown by the large amount of material condensed into fifty-two pages. While little of the material is new, the book will be of great assistance to those who wish to familiarize themselves with the present condition of the theory, as well as to those who wish to obtain a working knowledge of vector methods applied to physical problems. For the latter object no better course could be devised than a careful study of this book, with frequent transformations of the vector formulæ into their more familiar Cartesian equivalents.

The first chapter gives an outline of vector analysis, including the vector expressions for the more important analytical theorems of constant use. In the second chapter vector methods are applied to magnetostatics, and

here the advantages of these methods are most clearly brought out. The third chapter gives a statement of the Hertzian form of Maxwell's equations. In Chapter IV. Hertz's theory for moving media is discussed and it is shown how experimental results prove its inadequacy.

The motion of a single charge moving with uniform velocity through the ether is considered in Chapter V., and in the next chapter the electron theory of Lorentz is applied to stationary media. The treatment of stresses within a material medium is not satisfactory; no account is taken of the variation of specific inductive capacity with the state of strain, and therefore the stress system obtained is that of Maxwell, which we know is not capable of experimental verification. In the last chapter Lorentz's theory is applied to moving bodies, ending with a brief account of aberration. The interpretation of the Lorentz transformation in terms of the theory of relativity is not touched upon.

There are many other matters that might properly come within the scope of this work, but it does not profess to be exhaustive, and as an outline it may be commended most highly.

E. P. Adams

CONTAGIOUS ABORTION IN CATTLE

It is often asserted that tuberculosis is, from the economic point of view, the most important disease affecting the cattle of this country. It is undoubtedly true that contagious abortion is to be ranked as second in economic importance and, by many of the best informed breeders and dairyman this disease, that may destroy the usefulness of a dairy animal during one fourth to one half of the average period of productivity, is considered more important than tuberculosis. Certainly it is true that the breeder and dairyman have been more helpless in the fight against this disease than against tuberculosis, for knowledge is available that will enable any farmer to free his herd from tuberculosis and so to maintain it. In the case of contagious abortion, no such knowledge is available, and until quite recently no method had been devised by which it could be ascertained whether or not an animal about to be introduced into a healthy herd was infected. The work of Bang and his associates has demonstrated the cause of the disease as it appears in Denmark. This work has been confirmed by others in England and Germany. In the United States, in spite of the efforts of many investigators, the *B. abortus* of Bang had not been found. Dr. W. J. MacNeal, formerly at the University of Illinois, isolated an organism that he believed, relying on its cultural and morphological characteristics, to be identical with the Bang organism.

Within the last year, the complement deviation test, now so widely used for the diagnosis of syphilis, has been applied with great success to the detection of contagious abortion in cattle, by Drs. Bang and Holth in Copenhagen. Dr. W. P. Larson, who had become familiar with the test during his association with the Danish bacteriologists, returned to this country in May, since which time he has been engaged in connection with the departments of agricultural bacteriology and veterinary science of this experiment station in the study of the disease in this country. Using a culture of the organism brought from abroad as one of the specific components of the test, it has been shown that the disease as it occurs in this country is caused by the same organisms as found in Europe. Using the blood serum of known infected animals, the complement deviation test can be employed to identify a suspected organism. The organism has been isolated from fetuses from five herds in various parts of the state and the identity of the cultures established by the test. There remains no doubt that the disease in this country is caused by the same organism as that found in Europe.

H. L. Russell,
Director

Agricultural Experiment Station,
Madison, Wis.,
September 1, 1911

SPECIAL ARTICLES

A COUNTING METHOD FOR THE MECHANICAL ANALYSIS OF SOILS[1]

MANY investigators have worked on the problem of the mechanical analysis of soil, notably, Osborne,[2] Hilgard,[3] Hopkins,[4] Briggs,[5] Yoder[6] and Atterberg,[7] and the final result seems to indicate that some form based on sedimentation in water is the most serviceable for practical purposes. However, it may be of interest to soil workers to note a counting-plate method which approaches the problem from a different angle.

The counting-plate method has been used for the determination of soil particles in an attempt to save the time of centrifuging and evaporating the silt and clay suspensions. The sand is obtained by subsidence as in the regular method. The total weight of the silt and clay is determined by difference. The relative amounts are then obtained as follows:

The method is based on counting the number of silt and clay particles on a counting plate and from the relation thus established to determine the amount of clay and silt in the soil. This is an adaptation of a method employed in many different lines of work where both the number and diameter of small grains are to be obtained; as in the examination of blood, starch, etc. This method is not recommended for general use with soils, and should be used only where time is especially important or the facilities are not available for the determination of silt and clay as described above.

A definite amount of soil is weighed out, put in a sterilizer bottle with water and ammonia, and shaken in a mechanical shaker for at least seven hours. With most soils one half gram material and 120 cubic centimeters water give a good dilution for accurate counting. A compound microscope with a micrometer eyepiece and a counting plate are necessary. In the micrometer used one scale division corresponds to 0.005 millimeter, the superior limit of the clay, and ten divisions to 0.05 millimeter, the superior limit of the silt. The counting plate is marked off in squares of 0.1 millimeter a side. After removing from the mechanical shaker, the contents of the bottle are thoroughly shaken by hand and a sample for examination immediately taken from the center of the bottle. A drop is placed on the counting plate and the number of silt and clay particles in ten squares counted. The sand need not be considered. In most cases it settles quickly and escapes being taken in the subsample. If a sand particle appears in the subsample it is disregarded.

As one silt particle is much heavier than one clay particle, a factor must be used in obtaining a ratio to express the relative total weights of silt and clay in the soil. This factor was determined approximately by comparing the results obtained by counting with those obtained from analyses made in the regular way. For instance, soil No. 5,862 gives a count in ten squares of 26 silt particles and 2,020 clay particles. The regular analysis gives 23.06 per cent. silt and 45.78 per cent. clay, practically twice as much clay as silt. So first the number of silt particles (26) is multiplied by 2, giving 52. Dividing the number of clay particles (2,020) by 52 gives the factor 38 plus, or shows that 38 clay particles weigh as much as one silt particle. Therefore in this soil if we multiply the number of silt particles (obtained by counting) by 38, the result will be to the number of clay particles as the weight of the silt is to the weight of the clay. In 26 soils of widely varying texture, lately analyzed by the counting method and checked by the centrifugal analysis, an average of the factors was 35. The factors varied, however, widely enough to pre-

[1] Published by permission of the Secretary of Agriculture.

[2] Ann. Rep., Conn. Expt. Sta., 1886, p. 141; 1887, p. 144; 1888, p. 154.

[3] Ann. Rep., Cal. Expt. Sta., 1891–92, p. 243.

[4] Proc. Asso. Off. Agrl. Chem., Bull. 56, Division of Chemistry, U. S. Dept. of Agr., 1898, p. 67.

[5] U. S. Dept. of Agr., Bureau of Soils, Bull. 24.

[6] Bulletin No. 89, Utah Expt. Sta., 1904.

[7] Verhand. d. II. Inter. Agrogeol. Konf. Stockholm, 1910.

clude using this method as a regular routine analysis for all soils.

There are several reasons explaining the divergence of these factors from the average. To obtain one factor which would obtain for all soils, the silt particles (and likewise the clay) would have to be of a uniform size, shape and weight. These conditions do not exist in nature. However, if one size graded into the next, and the shape and specific gravity of the material were fairly uniform, the factors would still not be widely divergent. Another difficulty enters here; not only is this hypothesis doubtful, but it is not possible, on account of the great difference in size of the largest silt particles and the smallest clay particles, to have a counting plate and objective so calibrated that the very small clay particles could be counted and at the same time to give a field large enough to include a number of silt particles. So in order to get the silt it was necessary to use a low-power objective, and consequently many of the smaller clay particles were not counted.

The disadvantages of the method are that it is not applicable in every instance because of the small mass of clay particles in some soils; that the counts are not sufficiently uniform where great accuracy is necessary; and that in order to get the best results the operator must have a large experience in the usual methods of analysis.

C. C. FLETCHER

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ON A POSTERIOR COMMUNICATION OF THE AIR-BLADDER WITH THE EXTERIOR IN FISHES

RECENTLY, while examining the visceral anatomy of *Ophiocephalus*, my attention was called to what appeared to be a posterior communication of the air-bladder with the exterior. My species is *Ophiocephalus maculatus*, and before its death had been an aquarium pet of a Chinese in Redwood, California. Hence from whence it came is not known, but doubtless from somewhere in China, for many of this singularly hardy fish are carried alive by the Chinese from their home country.

The abdominal cavity of *Ophiocephalus* extends for a greater distance behind the anal opening than in front of it for the accommodation of the very long air-bladder, which reaches almost to the base of the caudal fin. About midway in the length of the air-bladder a wide tube of thin membrane is attached, which opening at its lower end to the exterior through the genital pore, appears at first sight to be a duct from the air-bladder, more especially as it is of the same white, glistening membrane. It, however, ends blindly against the wall of the air-bladder where it is so firmly attached by the incasing fibers of the latter extending over and around it that considerable tearing is necessary to detach it. Both the tube and the air-bladder, where the tube joins, were opened and examined under the microscope but no opening was found in either. The end of the tube is round and blunt. Into its lower end the vas deferens opens. Just above where the vas deferens enters, or just below the middle of its length, the tube expands into a large triangular pocket with a blunt point directed forward.

Almost a century ago Weber ("De aure et audita Hominis et animalium," Leipzig, 1820, p. 73) described in *Clupea harangus* a communication from the posterior end of the air-bladder with the exterior through a duct opening with the vas deferens into the genital pore. This condition being so nearly parallel with that described above for *Ophiocephalus* leads me to question whether the tube described by Weber was not also a blind tube, and not actually opening into the air-bladder.

Having no specimens of *Clupea harangus*, and having other problems on hand, I have not attempted to go more deeply into this subject. As the supposed fact that *Clupea harangus* has a posterior opening to the air-bladder has been repeated several times since the time of Weber without any one attempting to verify his work (or at least indicating that he has verified it), it is desirable that some one do so. I pass the problem on for what it may be worth.

EDWIN CHAPIN STARKS

SCIENCE

FRIDAY, OCTOBER 20, 1911

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MEDICINE AND SOCIOLOGY[1]

IT is a pleasure to have this opportunity to be with you at your commencement exercises. Rush has attracted many Wisconsin graduates medically inclined. Not only in the present graduating class but also among the members of your faculty I greet not a few Wisconsin men. Furthermore, the University of Chicago, with which Rush is officially affiliated, has a course in the premedical and medical sciences similar in ideals to the one we have at Wisconsin. In the premedical course at Chicago in addition to physics, chemistry, biology and a modern language some work is required in social science. Work of this kind is advised but not required at Wisconsin, but I am not sure but that it should be required there. There is ever greater need for sociology in medicine.

On the one hand, medical problems are at bottom social problems and are to be wisely solved only by those who have some knowledge of social science. On the other hand, the increasing complexity of the social organization brought about by the introduction of machinery and of rapid means of transportation of people, materials and news, the urbanization of the population and industrial concentration, have developed social problems which demand above all else the intelligence of men broadly trained in medicine. The triumphs of civilization are due to organization, to the subordination of individual whims to broad social aims. Its failings, on the other hand, are in large part due to the too constant appeal to selfish personal in-

[1] Address delivered at the commencement exercises of Rush Medical College, June, 1911.

terests as an inducement to social effort. Much that is weak and inefficient in the treatment of disease by physicians is due to a too narrow preliminary training, to a too restricted attitude, to a selfish, competitive, unprogressive individualism, archaic and out of place in modern highly organized society. Many of the worst evils of our present-day civilization, dirt, ill health, despondency, pauperism and crime, are in large part due to the failure on the part of the majority of those trained in medicine to act as leaders and public educators. Health of body and of mind should be recognized as of first importance to the community. "They have been so recognized, so far as they have been understood," says Havelock Ellis, "in every great period of civilization of which we have much knowledge, as Roman and Moorish ruins alone suffice to testify. That they are not so recognized to-day is the chief element of rottenness in our civilization. We postpone laying the foundations of our social structure in order to elaborate its pinnacles. We have not yet learned that a great civilization is ill built up on the bodies of men and women enfeebled and distorted by overwork, filth and disease " ("The Naturalization of Health," 1892).

The marvelous advance in industrial productivity characteristic of the past century is due, on the one hand, to the ideal of learning all that is possible about nature by observation and experiment, in a word to scientific research, and, on the other hand, to the organized application of this knowledge to human needs. It seems not improbable that during the coming century an equally earnest effort will be made to learn the truth about mankind, by observation and experiment, in order that the application of knowledge to human needs may be made more efficient. Medicine as a science occupies a unique position in that, on the one hand, it is closely bound up with the physical sciences on which industrial productivity depends, with physics, chemistry and biology, while, on the other hand, it deals directly with people in their social relations and is therefore intimately related to sociology. This latter relation has not been sufficiently recognized hitherto by either medical men or sociologists. With the application of a scientific sociology to the needs of mankind the importance of medical science will come more and more to the fore.

About fifty years ago a witty Englishman said that the ancients had tried to make of medicine a science and had failed, the moderns had made of it a trade and had succeeded. There is truth in the statement. The medicine of the ancients was rather an art than a science. Empirical practise was ahead of the theories used to explain the nature of disease and its treatment. Medicine is still too frequently looked at from the standpoint of a trade, but since the Englishman gave his cynical opinion medicine has progressed as a science more than in all the centuries before.

In the development of medicine four stages may be recognized, a demonic, a hygienic, a physiologic and an etiologic.

In demonic medicine disease is looked upon as an evil spirit which has taken possession of the body and which may be scared out by elaborate ceremonies usually accompanied by noise and supposedly fearful looking objects. This type of medicine is found in practically all savage tribes and wide-spread even in semi-civilized countries like China and India and is not unknown in a less crude form in modern America.

In hygienic medicine disease is looked upon as an abnormal functioning of the body which can in large part be over-

come by methods useful in keeping the body in healthful activity, by regulation of the diet, sleep, air, bathing, exercise and mental recreation. This type of medicine was brought to a high stage of development by the Greeks, among whom personal hygiene was practised to a degree of perfection which it has never elsewhere reached. To Hippocrates are ascribed the works in which the hygienic medicine of the Greeks is summarized. It has formed the basis of much of the best medical practise ever since. If, however, as some historians believe, the decline of Greece was due in large part to malaria, the Greeks in the end served to illustrate the inadequacy of merely hygienic medicine.

Physiologic medicine is based upon centuries of study of the structure and functions of the body in health and disease. It began among the Greeks soon after the time of Hippocrates and reached its highest development during the nineteenth century. It seeks to determine accurately just what structural or functional disturbances underlie the symptoms of a given disease, to what extent the disturbances are beneficial and to what extent detrimental, and what may be done to allay the detrimental and excite the beneficial disturbances. It has given rise to refined methods of diagnosis so that lesions of the heart, the lungs, the kidneys and other vital organs may be determined with considerable accuracy, and steps taken so far as possible to overcome these defects by use of drugs, operations or carefully regulated habits of living. It has shown that not all symptoms of disease are signs of an injured mechanism, but rather may frequently be signs of a vigorous healthy fight against invasion. Thus fevers are frequently, if not always, accompanied by the production of living cells or of chemical substances which attack invading disease germs. The fight may be lost and the mechanism may be permanently damaged, but on the other hand the fight may be won. That a fight won against a mild invader may enable the body to resist a stronger one was shown in the latter part of the eighteenth century by Jenner, who discovered that inoculation with cowpox will protect against smallpox. This great discovery of vaccination soon proved a blessing to mankind, but nearly a century passed before scientific knowledge and methods became sufficiently developed to give us the Pasteur treatment for rabies, the Behring serum treatment for diphtheria, and the opsonic therapy of Wright, all based upon the idea either of stimulating the normal power of the body to resist disease or of stimulating an animal to resist disease and then utilizing its resistance products by injecting them into the human body. These biological methods of treating infectious or contagious diseases are to be contrasted with the merely chemical methods of which until recently but two were known to be specific: mercury in syphilis, derived from the Arabian use of the drug in cutaneous affections, and quinine in malaria, derived in the eighteenth century from the use by natives of Peru of Peruvian bark to cure fevers. Recently the genius of Ehrlich has enabled him to add at least one new specific drug, another cure for syphilis, and to open a new field for work.

In another direction physiological research has shown that when an organ whose secretions are needed for normal activities is deficient its place may sometimes be taken by extracts from organs of the lower mammals. The use of thyroid extract in cretinism and myxœdema is one of the greatest gifts of physiology to medicine. Nothing is more astonishing than the development of a cretin, otherwise des-

tined to a dwarfish, toad-like existence, into a nearly or quite normal individual when fed on the extract of thyroid glands of the sheep.

Modern surgery is an outgrowth of physiological medicine, although many of its triumphs are due to asepsis, and this in turn is a product of the stage of medicine next to be considered, the etiologic.

Etiologic medicine seeks to determine the causes of disease and to deal directly with these. It is a direct outgrowth of physiologic medicine and has really been the aim of the foremost students of the physiology of disease. While the causes of some diseases have been fairly well understood for many years, etiologic medicine was first really placed on a firm basis by the genius of Pasteur and Koch about fifty years ago. In infectious and contagious diseases the specific organisms and their mode of transmission have been discovered in a large number of cases, and in others much has been learned even where the specific organism has not yet been discovered. Thus one species of mosquito is known to transmit malaria, another to transmit yellow fever. The malarial organism is known, that of yellow fever is not. Malaria can be fairly successfully treated with quinine. There is no specific for yellow fever. Both diseases can be abolished by getting rid of the mosquito. Typhoid fever, for which there is no specific, can be gotten rid of by guarding water and food supplies and for a time, at least, guarding the public against typhoid carriers, people who harbor the germ without themselves being sick. Such carriers, however, would probably not exist where the water and food supplies have been kept pure for years, except, of course, as they might come in from outside. Tuberculosis is a more difficult problem, but by guarding the air and food supply and by teaching consumptives how to keep themselves from infecting others great advances can be made toward getting rid of this disease.

Tuberculosis offers perhaps the best example of advance from the physiologic to the etiologic attitude toward disease. The history of recent advance in the study and treatment of tuberculosis has recently been well summarized by R. W. Phillip ("Progressive Medicine and the Outlook on Tuberculosis," *British Medical Journal*, 1909).

The remarkable advance in the medical sciences during the last half century has been due chiefly to the development of research laboratories in universities, in special research institutions and in the government service. In spite of relatively meager funds these institutions have provided instruments and inspiration for search for the truth; the work has been led by men of genius, and has been organized so as to promote cooperation without destroying initiative. For the most part these research laboratories have been connected with laboratories of medical schools, although in this country such connection has been unfortunately too rare. Where such a connection exists, as at Chicago and Rush, the investigator is stimulated by the youth about him while the younger men are inspired with ambition for that real power which comes from scientific knowledge.

In the application of medical science to human needs America has been much more backward than in the advance of medical science. This is due probably chiefly to the fact that a very few men can advance medical science enormously if they be of the caliber to discover essential truths and have the right environment. One or two research institutions or a government inclined to give even meager support to medical investigation makes possible the

work of a Walter Reed, who is primarily responsible for the proof of the conveyance of yellow fever by mosquitoes, or of a Ricketts, whose work on spotted fever and on typhus fever will, in spite of his untimely death, cause his name to be lastingly remembered. On the other hand, in order to have an affective application of medical science to human needs there must be a sufficient number of men well versed in the science to make it possible to educate the whole people to its practical value in the broadest sense. This, owing partly to the backwardness of so many of our medical schools, we have not had. In the Wisconsin legislature, a "progressive" legislature at that, bills relating to instruction in hygiene and to medical inspection in the public schools have failed to pass because a handful of christian scientists exerted more influence than a medical profession of three thousand. On the other hand, this same legislature has been quite liberal in providing for state and county institutions for the care of tuberculous patients, but here there has been public education largely led by laymen.

Demonic medicine to a large extent still holds sway. Among the christian scientists the evil spirit is known as "error," among the chiropractics and similar cults as "dislocated vertebræ," among the people, at large as something vaguely formulated but none the less something to be driven out by various kinds of patent medicines for which each year many millions of dollars are spent. The cures which these various forms of demonic medicine sometimes effect are ascribed by the scientific to the action of the stimulated imagination on the body. This has given rise to a new "psychotherapy" in which the effect of mind on body can be utilized scientifically. Psychotherapy, however, is to be looked upon as a branch of physiologic medicine. Demonic medicine has no longer a place in a truly civilized community.

Hygienic medicine, on the other hand, is a lasting gift from the Greeks to civilized mankind. Its basis is personal hygiene, the right use of exercise and rest of mind and body, diet, bathing, fresh air, sunshine, proper clothing and the like. It is primarily the medicine for the home and must depend largely on the intelligence and education of home-making women. In its more specialized aspects for the cure rather than the prevention of disease it is highly developed in our better sanitariums where regulated exercise, selected diet, hydrotherapy, electrotherapy and the like are carefully designed to restore a weakened individual to healthful strength of body, and in hospitals for the insane where the aim is to restore the mind. During the past fifty years in the hands of trained nurses it has transformed general hospitals throughout the world from places of excessive mortality into the safest places in the world in which to be sick. For years to come it appears that trained nurses are likely to be able best to carry its lessons into the schoolroom and the home as they already have into our hospitals, thanks largely to the genius of Florence Nightingale. Modern surgery owes its triumphs fully as much to the trained nurses in our hospitals as it does to anesthetics or asepsis. School nurses to look after the health of school children under the supervision of medical inspectors, and district nurses to carry the lessons of hygienic medicine into the homes where at present babies are so badly cared for that a fifth of them die in the first year and a third die before the age of five, are essential for the advance of health under the guidance of medical science. To the physician engaged in private

practise the nurse trained in hygienic medicine is indispensable.

The practitioner, although he must be able to apply or to direct others to apply appropriate hygienic measures, is himself primarily responsible for physiologic medicine, for the accurate diagnosis and medical and surgical treatment of the sick individual. He must be able to determine accurately the condition of the more important internal organs and be able to apply drugs or other treatment with due regard for these conditions. While many rough-and-ready methods of diagnosis may be used in the home or at the office, many of the more refined methods are here excluded by lack of time or equipment. Thus only too frequently a serious condition is overlooked at its inception and when discovered is so far advanced as to make a cure difficult or impossible. A large percentage of cases of tuberculosis are not recognized until well advanced, in spite of the recent agitation about the disease. This neglect to recognize tuberculosis early will be a standing disgrace to the profession so long as it exists.

Under present conditions of private practise crude, rough-and-ready methods of diagnosis are in many cases the best that can be utilized. A refined method poorly executed is worth far less than a rough method carefully and intelligently used by an experienced, keen-sighted, thoughtful man. But the public has a right to demand the more refined methods. Within a generation we have seen most of major surgery transformed from the home to the hospital. There the surgeons can depend not only on the nursing staff to provide better hygienic treatment than is possible in the home but he can also in a well-manned hospital depend on the internes to utilize many of the more refined and time-consuming methods of diagnosis. To these factors surgery owes no small part of its success.

In internal medicine the hospital is likewise becoming more and more utilized. Sanitariums with highly developed means for applying hygienic treatment have long been popular in the treatment of chronic troubles. Hospitals have not been sufficiently used for the diagnosis and treatment of disease in its inception and less severe aspects, but everything points to a rapid development in this direction. What is needed is more cooperation and less competition among the physicians in any given community. With better cooperation hospitals fitted for diagnosis and treatment could readily be established in sufficient numbers to give every physician a real hospital connection, except possibly in some very small towns. Each hospital should have a laboratory managed by one or more men skilled in the laboratory diagnosis of disease. There would then be no longer an excuse for mere rough-and-ready methods of diagnosis. Nor would it be necessary for the more scientifically inclined physician to maintain at great personal expense a private laboratory of his own. A greater amount of specialization on the part of the various physicians in a community would likewise greatly add to their efficiency, provided the specialization came on top of, not at the expense of, a broad medical training.

In sanitariums it is customary to make a general charge for room and treatment, special fees being made merely for surgical operations. The physician at the sanitarium, if not the owner thereof, is usually on a salary. At general hospitals the charge is usually for room and nursing, and other hospital care, the patient, if able to pay, paying the physician or surgeon caring for him directly for his treatment. The medical staff of the hospital seldom is

on a salary, although a small sum, in addition to room and board, may be paid the interne. At the Johns Hopkins Hospital, where some of the members of the staff have always had some salary as compensation for their care of the indigent, it has recently been proposed to put all of the members of the regular staff on a salary basis, on the understanding that they are not to engage in private practise. The private patients at the hospital would pay the hospital directly, and not the attending physician or surgeon, for their medical care. How widespread such a movement will become can not at present be predicted. In all probability, however, for many years to come the majority of physicians will depend for their support upon fees from patients rather than upon a salary from a hospital or other organization. The freer use of hospitals by no means precludes this.

On the other hand, it is quite apparent that the custom of the employment of physicians on a salary to give medical attendance to groups of people is growing throughout the civilized world. In public institutions for the care of the criminal, insane and defectives, as well as in the army and navy, this custom has long prevailed and in this country has received the general sanction of the medical profession. The employment of physicians by corporations to look after men in remote districts has also received general sanction. But the profession has not looked favorably on the employment by corporations of physicians to look after employees and their families in settled communities where there is an abundance of private practitioners. Nor has the profession looked with favor on the employment at a salary by lodges and other social organizations of physicians to look after members and their families. "Contract practise," as these forms of practise are called, has a bad name, in large part deserved, because too often a physician will contract to treat for a sum too small to make good service possible. When a fair salary is paid for first-class work no legitimate criticism can be made. Certainly there is nothing sacred about the prevalent system of small fees for visits, fees which resemble in some respects tips to a servant for personal service, except that the physician's fee is less often paid in cash. On the other hand, there is nothing especially to be commended in the custom of the specialist, Robin-Hood-like, to hold up the rich sick to pay for the sick poor. The public at large should pay for its necessary charity.

A physician should be paid for his time and his skill and be paid enough to make it possible for him to give good service and improve himself in his profession. But whether he is paid a salary or a fair amount for a definite service makes little difference. The evil to the medical profession of the medical insurance laws of Germany comes not from the fact that the state hires physicians to treat the insured, but from the fact that the state pays far too little for this service.

Much complaint is made of the large numbers who seek free treatment at dispensaries and hospitals in our larger cities, frequently a quarter or more of the population. It is doubtful if so large a part of the population are either paupers or dead beats. Many can not afford fancy fees and know of no way of getting the best treatment except to go to a dispensary or hospital where treatment is organized. Make it possible for the average man to get the benefits of organized treatment at a moderate charge and a large part of the so-called dispensary and hospital abuse will disappear.

There will doubtless always be some necessity for charity work. The com-

munity should pay the hospital and the physician for such as is really necessary. To what extent, beyond mere charity work, the public should pay for treatment of disease by physicians there is room for an honest difference of opinion. Some would have all medical treatment furnished free by the state, others would have none. Most of the profession, as pointed out above, approve of the state employing physicians in the army, the navy and in charitable and penal institutions. In public educational institutions the state is under special obligations to safeguard the health because of the compulsory features of our educational laws. While much can be done along the lines of sanitation and preventive medicine in the schools, much treatment must be given individual pupils if this work is to be effective. Where the law provides for medical supervision of the schools it usually provides that the family of the child shall be notified of the need of treatment and shall be expected to employ a physician for this purpose, except in charity cases where special provision is made. At present this is probably the most practical system, although only from twenty to eighty per cent. of children needing treatment actually get it. It is most efficient where there are school nurses to follow the children to their homes and explain matters to the parents.

The need of proper medical treatment during school life is illustrated by the son of a well-known physician. The boy was slow in the grades, and took five years to get through college. In some doubt the father allowed him to begin a course in medicine. Soon after he entered the medical school some one suggested he needed eye glasses, although he never had supposed he needed them. When these were obtained a new world was opened, continued study became possible and marked professional success followed. A pair of glasses in the primary school might have saved the boy some years in school and much chagrin.

In normal schools, colleges and universities an increasing amount of attention is being given to caring for the health of the students. This care takes several forms. Instruction in personal and public hygiene is now quite general and is required in a majority of colleges. Departments of physical training designed to promote physical health are also quite general. Committees to look after the sanitation of the grounds and buildings are common, but have not in most cases been given sufficient authority to do really efficient work. Class-room ventilation, for instance, is in general wretched. In several of the universities infirmaries are provided to take care of sick students and in others medical advisers or school physicians are engaged to advise or treat those who are ill. Sometimes a special fee is charged each student to provide funds to cover the cost of this medical service, at other times it is paid for out of general university funds and in some instances treatment is free for poor students while the well-to-do are supposed to pay for services received.

At Wisconsin we have a medical adviser with a staff of three assistant physicians, two nurses, a trained laboratory assistant and an office attendant. Careful medical examinations are made of all freshmen and of such upper classmen as require it. Regular daily office hours are held for consultation with students, office treatment is given and some visiting is done at rooming houses of students confined there by illness, although in severe or prolonged illness the student is expected to get his own physician when he can afford to pay. More treatment is given than was originally contemplated, but our experience in Madison has

demonstrated that mere advice counts for little unless it comes from one whose ability to do commands respect. The hygienic talks given to individual students by the medical adviser and his assistants are far more effective than any public lectures on hygiene could be, because the staff commands the respect of the students by its ability to diagnose and treat disease. This, I believe, will be found generally to be the case in all institutional medicine.

In the diagnosis and treatment of disease etiology plays an important part, but the great triumph of etiologic medicine lies in the possibilities for preventive and social medicine which it has opened up. In preventive medicine the state through education, legislation, inspection and regulation plays an essential part. Preventive medicine can only be made effective where the state employs highly trained men to look after sanitation and hygiene. Nearly all diseases at bottom are social and can be properly repressed only by social cooperation.

Indeed even the most individualistic diseases, congenital defects of various sorts, may be frequently traced either to bad or vicious surroundings of the parents or to a bad ancestral line on one or both sides. Eugenics, the new science which seeks to determine the laws necessary for propagation of an improving species, will have to be studied both by the family physician who is to be a wise councilor and by public health officers who aim to be good teachers and guides. Sociological medicine begins not only before birth, but even before conception. The life of young women must be made healthful, young men must be made to understand the lasting effects to the third and fourth generation of drink and the social vices.

At birth again sociologic medicine has its important part to play. When the clean hospital with its specialists comes to be substituted for the dirty midwife and the so frequently bungling general practitioner years of ill health and suffering will be saved the larger share of our married women and our blind asylums will become one fourth too large. Havelock Ellis estimates that in England in 1891 midwives were responsible for the deaths of three thousand women. They were doubtless responsible for the lifelong suffering of many more. It is estimated that about a fourth of the blindness in our blind asylums is due to lack of proper care of eyes at birth.

During infancy the death rate is frightful. While doubtless the fittest survive, they do not survive in the fittest way. An abundance of well-trained district nurses under careful medical supervision could do untold good in this field of sociologic medicine.

A fifth of the population are in the public schools. Here sociologic medicine has already made a good start. In most of the large cities moderately efficient medical supervision has already been established and in the smaller towns it is beginning. Massachusetts has a state law making it compulsory in the public schools to provide a medical adviser and several states have permissive laws. It is the duty of the medical inspector to see that children suffering from contagious diseases are excluded from the school during the infectious period, to examine for defects in the eyes, ears, nose, teeth and throat, to advise treatment when necessary, and in general to look after school hygiene and sanitation. As already twice pointed out, the school medical inspector has his efficiency greatly increased when school nurses are attached to his staff. It has been suggested, quite wisely, I think, that there be an abundance of school nurses who can not only follow the children to their homes and see that

they are cared for, but also act as district nurses to give advice concerning care of infants and general hygienic conditions. The greatest drawback to medical inspection has been lack of sufficient funds to employ enough specially trained men and women at full time to do the work thoroughly. Open-air schools for weak children and special schools for defectives are a natural outgrowth of medical supervision of school children. Chicago is to be congratulated on the splendid start she has made along these lines.

While we can depend on proper medical inspection in the schools and school and district nursing for a great improvement in personal hygiene and in the popular intelligence concerning medicine and hygiene, the care of the public health will depend in no small degree on efficient officers of public health. At the present time these are rare in the United States.

A vast amount of preventable disease exists for which there is no intelligent excuse. There should be practically no typhoid fever, but thousands die from it yearly. Smallpox should be rare, but in the middle west it is quite common. Most of the contagious diseases could be greatly reduced by more efficient boards of health. The milk supply, in most cities, especially those of moderate size, is far too little intelligently supervised. Fortunately, conditions are changing and within the present generation there should be such a demand for well-trained officers of public health that it will be difficult to keep up the supply. Our medical schools will recognize that the training of public health officers is a duty equally important with that of training practitioners of medicine. At Wisconsin, next year, we are to begin a course in public health and we hope within a short time to find a real demand for such a course. The splendid public health work done by our government in Cuba, the Canal Zone and Manila shows what Americans should soon be doing at home. We need a national health bureau and we need in each state and in each district and municipality in each state thoroughly competent health officers. You young men about to graduate must do your best to promote this movement.

Efficient sanitation depends above all else on public education. In tuberculosis splendid progress has already been made along these lines, but much more remains to be done in the general field. The medical profession should do far more than it has done to educate the public. Sanitary laws will be efficient in a democracy just in proportion to the general intelligence about hygienic matters, and no more.

Medical advance depends, on the one hand, on scientific research, on the other on public education along hygienic lines. Every citizen should be inspired with love of personal and public hygiene as were the Greeks. Every physician should be deeply grounded in physiologic medicine and provided with proper facilities for using it practically. Every officer of public health should know thoroughly the contributions of etiologic medicine. All efforts should be made to promote these most fundamental needs of society. While most of you who are graduating to-day will become private practitioners, most of you will be in a position directly or indirectly to promote scientific medicine, public education and public sanitation. You have had as students at Chicago University and at Rush splendid examples before you in your faculty. With such examples none of you can fail to play well your part in helping in the organization of society along more hygienic lines and in the reorganization of medical practise to better fit the needs of modern society.

C. R. Bardeen

University of Wisconsin

LECTURES ON SOLAR AND TERRESTRIAL PHYSICS

A COURSE of lectures will be given between October 17 and 28, 1911, in the Physical Laboratory of the Johns Hopkins University, by Arthur Schuster, F.R.S., honorary professor of physics in the University of Manchester.

The object of the lectures will be to discuss the cosmical applications of recent advances in physics, to explain the methods of examining correlations between solar and terrestrial phenomena, and to specify the problems of solar and terrestrial physics which seem to call for special investigation.

The following headings are intended to illustrate the general scope of the lectures, but do not necessarily indicate the order in which the subjects will be taken:

1. *Preliminary Considerations.* The ponderomotive forces concerned (gravitation, radiation pressure, electrostatic forces). The laws of radiation (adiabatic, isothermal and radiostatic equilibrium).

2. *The Sun.* The interior of the sun, conditions at the surface due to ejection of electrons. Spectroscopic phenomena and their interpretation. The laws of solar rotation. The sun's corona. Sun-spots and their periodicity.

3. *Interplanetary Space.* Effects of small quantities of matter on thermal and electric conductivity.

4. *The Earth.* Our knowledge of its interior constitution. The age of the earth. The principal phenomena of terrestrial magnetism and atmospheric electricity.

5. *The Earth's Atmosphere*—more especially with regard to its condition near its upper limit.

6. *General methods of investigating periodicities.* Brückner's "35-year meteorological cycle" shown to be non-existent. Lunar effects. Connection between sun-spots and terrestrial phenomena.

DR. CHRISTIAN ARCHIBALD HERTER

IN response to an invitation issued by the President of the Johns Hopkins University and the Committee on the Herter Memorial Lectureship, a meeting in memory of the late Dr. Christian Archibald Herter was held in the lecture room of the Physiological Laboratory on Thursday, October fifth, 1911, at three P.M.

Drs. Welch, Halsted, Abel, Dunham and Flexner spoke of various aspects of the life and work of Dr. Herter and paid tribute to his character and his services to medical science.

The following minute was adopted and was subsequently read to the audience assembled at four o'clock to hear Professor Kossel's second Herter lecture, who expressed their respect and approval by a rising vote:

The medical faculty and other members of the Johns Hopkins University, as well as all assembled at the delivery of the sixth series of lectures upon the Herter Foundation, desire to place upon record their sense of the great loss sustained by American medicine and by medical science in the death of Dr. Christian Archibald Herter on December fifth, 1910.

The initiation of Dr. Herter's fruitful activity as a scientific investigator by his work as a graduate student in this university and his active interest in the development of this medical school are sources of especial gratification to the university. Upon this occasion especially we recall with grateful appreciation his generous benefaction in founding, in association with Mrs. Herter, a lectureship which has been and will continue to be a fountain of inspiration and instruction to our faculty and students and to the medical profession.

In the life and work and character of Dr. Herter we recognize the manifestation of rare gifts of intellect and of heart and high-minded devotion to the highest ideals of our profession and of scientific medicine. By valuable contributions to knowledge, by wisely directed and generous material aid in the promotion of medical and biological science, by judicious counsel and active effort and by the widely felt influence of a richly endowed, and singularly attractive and cultivated personality Dr. Herter rendered memorable service to American medicine in behalf of higher professional standards and wider recognition and cultivation of medical science.

In this university and elsewhere the memory of Christian Archibald Herter will be cherished not only as that of a generous benefactor, but also "as a presence to be felt and known" exemplify-

ing love of beauty, broad humanity and loyalty and devotion to the best ideals of the physician and the student of man and of nature.

We desire to express our sympathy with Mrs. Herter and her children in their bereavement and that a copy of this minute be transmitted to them.

SCIENTIFIC NOTES AND NEWS

PROFESSOR ALFRED G. COMPTON, professor of physics at New York City College, with which institution he has been connected as instructor since his graduation in 1853, has at his request been retired on a pension.

SIR THOMAS CROSBY has been elected Lord Mayor of London. He is the first physician to occupy that office though he has had 723 predecessors.

PROFESSOR F. P. MCKIBBEN, head of the department of civil engineering at Lehigh University, has been appointed consulting engineer by the state committee which is investigating the causes of the disaster at the Austin dam.

THE Alvarenga prize, of the Philadelphia College of Physicians, valued at $180, was awarded to Dr. Francis D. Patterson for his thesis on "Parathyroid Glandules."

W. H. BROWN, Ph.D. (Hopkins '10), has gone as botanist to the Bureau of Science in Manila.

DR. CHARLES SHEARD has retired from the chair of preventive medicine at the University of Toronto.

THE Geographical Society of France has entrusted to Mr. R. Jarry Desloges the erection of an observatory, more or less temporary, on the high plateaus of North Africa.

MR. ROY C. ANDREWS will leave during the last week of November on an expedition to the orient on behalf of the American Museum of Natural History. He will visit the whaling stations of southern Korea, then outfit at Seoul and travel into the mountains of north Korea, a region unknown zoologically.

DR. ALBRECHT KOSSEL, who has been giving the Herter lectures at the Johns Hopkins University, will return to Germany on October 24.

THE program of the Geological Conference of Harvard University on September 17 consisted of papers on the shoreline changes in northern and southern Sweden, by Professor D. W. Johnson, and on the landslide at St. Alban, Quebec, by Professor Charles Palache.

PROFESSOR WILLY KUKENTHAL, visiting professor at Harvard University, lectured to the Zoological Club on October 19 on his studies on whales.

THE Harveian oration before the Royal College of Physicians of London was delivered by Dr. C. Theodore Williams, on October 18.

THE *Journal* of the American Medical Association states that a committee consisting of Provost Edgar Fahs Smith, Ph.D., Dr. S. Weir Mitchell, Sir William Osler and Drs. William Pepper, Clarence Payne Franklin and Swithin Chandler, Philadelphia, has been formed to take up the project of erecting at Philadelphia a fitting monument to John Morgan, founder of the first medical school in the United States, and director general of the hospitals and physician-in-chief of the American Army during the revolutionary war.

WE learn from *Nature* that it is proposed to erect a memorial to Mungo Park and Richard Lander. A committee has been formed consisting of Lord Curzon, Sir George T. Goldie, Lord Scarbrough, Major Leonard Darwin, Sir Walter Egerton and Sir Hesketh Ball to take the necessary steps to secure funds for this purpose. Both explorers have been honored in their native towns of Selkirk and Truro, but no record of any kind exists in the land to which their lives were consecrated and sacrificed.

IN the issue of SCIENCE for October 6 the age of Mr. Edward Whymper is given as 61, while it should be 71, as he was born on April 27, 1840.

SIR HERBERT HOPE RISLEY, known for his anthropological studies in India, died on September 30, at the age of sixty years.

DR. WILHELM DILTHEY, formerly professor of philosophy in the University of Berlin, died on October 5 at the age of 77.

Professor Oskar Kellner, director of the Agricultural Experiment Station at Möckern, died on September 22, aged sixty years.

Among the positions that will be filled by a New York State Civil Service examination on November 11 is that of inspector in mathematics in the Education Department, at a salary of $2,000.

Announcement has been made by the board of trustees of Stanford University of a gift of $10,000 made by Dr. Adolph Barkan, San Francisco, professor emeritus of the medical school, for the establishment of a special library dealing with diseases of the eye, ear, nose and throat. A gift of $5,000 from Charles C. Stanford for medical library purposes was also announced.

The fourth annual meeting of the Association of Official Seed Analysts will occur in connection with the other meetings for workers in agricultural science at Columbus, Ohio, November 17 and 18.

Professor Albert S. Bickmore has given his personal library and almost unequalled collection of lantern slides to the American Museum of Natural History. The collection comprises more than 20,000 lantern slides, of which about 12,000 are colored.

The American Institute of Mining Engineers held its 101st meeting in San Francisco beginning on October 10. After the meeting members had arranged to embark on the steamships *Manchuria* and *Siberia,* leaving San Francisco on October 17 and arriving in Yokohama on November 3. It is planned to spend eighteen days in Japan, leaving Yokohama on November 21, arriving in San Francisco on December 7. The excursion in Japan will include trips to the Tokio, Nikko and Chuzenji district, Kiota, Nara, Osaka, Kobe, Ikuno, silver mine, imperial steel works, etc.

A meeting of the International Commission on Mathematical Teaching was held at Milan on September 18–21, Professor F. Klein presiding. It is stated in *Nature* that the main subjects discussed were: (1) The question of rigor in teaching mathematics, especially geometry. It appears that of European countries Italy is the most wedded to rigorous methods, while Germany and Austria stand at the other end of the scale, and admit intuitive methods freely. France and England adopt a middle course, France inclining toward the Italian practise and England toward the German. It was agreed that Euclid does not satisfy modern standards of mathematical rigor. (2) The question of "fusion," *e. g.*, of geometry with algebra, of plane with solid geometry, of geometry with trigonometry, of solid geometry with descriptive geometry, of analytical with geometrical conics, of differential with integral calculus. (3) The provision of mathematical instruction for students of such subjects as chemistry, biology and economics. Such courses were at one time provided in French universities, but are now entrusted to the schools. In other countries there does not appear to be any systematic provision of this kind. The reports issued by the various national subcommissions were presented; of these, the French reports are now complete; eight of the thirty-four English reports have been issued by the Board of Education (Wyman and Co.), and a large amount of literature has been issued by the German subcommittee, whose labors, however, will not be completed for two years more. Arrangements were made for the educational subsection at the International Mathematical Congress to be held at Cambridge (England) on August 22–28, 1913.

The new session of the Royal Geographical Society, of which Lord Curzon is president, will be opened on November 6, when, as we learn from the London *Times,* Dr. Fridtjof Nansen will give a paper on the Norsemen in America. On November 20 Dr. Tempest Anderson will give a paper on Volcanic Craters and Explosions. At the next meeting, on December 4, Sir Alfred Sharpe, who has recently retired from the Governorship of Nyasaland, where he has been for many years, will deal with the geography and economic development of British Central Africa. On December 18 Dr. D. T. McDougal, of the

Carnegie Institute, who has been studying on the spot for a considerable time, along with Mr. Ellsworth Huntington, the desert conditions of Arizona, will give a paper on American Deserts. Sir William Willcocks, whose paper on Mesopotamia last session created so much interest, will deal with his further researches on the Garden of Eden and its restoration. Dr. Mackintosh Bell, late director of the Geological Survey of New Zealand, has promised a paper on an Unknown Corner of South Island. Mr. Douglas Carruthers, who has made extensive explorations in Central Asia during the last 18 months, will give a paper, probably in March, describing the results of those journeys. Mr. A. J. Sargent will deal with the Commercial Geography of the Tyne Basin, and Mr. P. A. Talbot with the journeys in the central Soudan along with Mrs. Talbot and Miss Olive MacLeod. In January or February a course of three lectures will be given in the afternoon on the Desert of North Africa, by Captain H. G. Lyons, R.E., F.R.S., formerly director of the Egyptian Survey. The Christmas lectures this session will be, on January 5, by Mr. Julian Grande, the subject being "Amongst the Alps"; on January 8, by Mr. W. Herbert Garrison, on "Our World Wide Empire"; and on January 11 "A Lady's Journeys in the Central Sudan," by Miss Olive MacLeod.

Many glacial moraines contain particles of gold, yet the metal is very rarely so abundant as to make their treatment profitable. This is due to the fact that running water has not had opportunity to concentrate the precious metal scoured by the glacier from the decomposed surface of the mountains. In a short report, however, just issued by the United States Geological Survey, F. C. Schrader gives an interesting account of gold-bearing ground moraines at Kennedy Creek and Libby Creek, Montana. The Kennedy Creek deposit, says Mr. Schrader, is commonly known to mining men who have examined it as ancient lake gravel, but it seems plainly to be a subglacial or ice-laid deposit of till—a ground moraine. The material is evidently derived from the upland mountains on the northeast, whence it was scoured off the surface by the ice sheet, shoved and dragged down the slopes, crushed, ground and finally compressed beneath the ponderous ice mass. The ice sheet probably covered the basin with a thickness of a thousand or more feet for a period of centuries. A most unusual feature is the fact that this glacial deposit does not seem to have been concentrated by later streams nor to have derived its gold from preexisting placers. If this view is correct there must occur in the mountains or uplands to the northeast, in the path of the ice that deposited the moraine, some rich gold-bearing vein or bedrock area as yet undiscovered. Tests made of the deposit in six different shafts fairly well distributed over about half a square mile in the southern part of the basin show the gold content of the deposits to range from 20 cents a cubic yard near the surface to about $5 a cubic yard in the bottom foot of gravel next to bedrock, from which it is readily apparent that the deposits contain considerable gold. By some mining men the amount of gold present in the basin has been estimated at $18,000,000. From the data obtained in the present tests, after reasonable allowance is made for bowlders, which in the lower part of the section constitute about 10 per cent. of the material, the deposit in the southern part of the basin seems to contain on the average about 80 cents a cubic yard, including everything from the surface down to bedrock, or about $4 a bedrock yard. This would amount to about $17,360 an acre, or more than $5,500,000 for the Kennedy placer portion of the area examined. The estimate does not include the neck of the deposit in the downstream outlet, which in places attains a thickness of 80 feet or more and is known to carry considerable gold. In the basin as a whole, if gravel of this grade is present throughout, there is probably more than $11,000,000 worth of gold. The entire district of which Kennedy Creek is a portion is roughly estimated by Mr. Schrader to contain about $100,000,000 worth of gold, much of which, he states, to judge from the attention the district is receiving, will probably be won in the near future.

UNIVERSITY AND EDUCATIONAL NEWS

A fifty-acre piece of level land recently reclaimed on the Cambridge side of the Charles River basin, between the Harvard and West Boston Bridges, has been selected for the new site of the Massachusetts Institute of Technology. The selection is contingent on favorable action by the city of Cambridge in closing up certain streets.

President W. H. P. Faunce announces that $400,000 of the endowment fund of $1,000,000 which Brown University is endeavoring to secure, has already been subscribed. The general education board has contributed $150,000 and eight gifts of $25,000, together with smaller amounts aggregating $50,000, have been received.

Mr. Charles Scribner has given to Princeton University a completely equipped printing plant, provided at a cost of $125,000.

Six new buildings are to be erected at the University of Wisconsin during the present school year. The first of these is a $200,000 woman's dormitory, three stories high and of fireproof construction. A feature of this building will be its division into two separate parts, each part to have a separate dining room, parlors, music room, etc., for the women of each section. The second building to be erected is the $115,000 building for the department of home economics and for the extension division. This building will consist of a large central portion with two wings. It will consist of three stories and basement and will be built of pressed brick with stone trimmings. A new building for the department of agricultural chemistry, to cost approximately $100,000, will be started next month. This building will also be constructed of brick and will follow the general lines of architecture of the agricultural engineering building and the agronomy building. The other improvements to be made this year include an annex to the gymnasium and armory, a west wing to the chemistry building and a west wing to the library. The new agronomy building, started last fall, will be ready for occupancy in a few weeks.

Dr. Arthur S. MacKenzie, who left the chair of physics at Dalhousie University for the same position at Stevens Institute last year, has been appointed president of Dalhousie University.

Dr. Bradley M. Davis has been appointed assistant professor of botany in the University of Pennsylvania. He will offer work in plant cytology and genetics, and a course on the morphology of the algæ and bryophytes alternating yearly with a course on the morphology of the pteridophytes and gymnosperms.

Mr. Winslow H. Herschell, technical correspondent of the Allis-Chalmers Company in Zurich, has been appointed assistant professor of mechanical engineering in the University of Maine, to succeed Mr. W. M. Curtis, who has resigned to engage in practical work.

Dr. Rheinart P. Cowles has resigned his position as associate in biology in the Johns Hopkins University to enter on his duties as associate professor of zoology in the University of the Philippines.

The following promotions and appointments have been made in the School of Zoology at the University of Texas: Dr. J. T. Patterson, adjunct professor; Dr. D. B. Casteel, adjunct professor; Dr. A. Richards (Princeton '11), instructor; Mr. W. L. Brown and Miss Charlie Wilson, tutors; Mr. O. R. Lasater, Miss Ethel Taylor and Miss Mary Kirkland, student assistants.

The new appointees in the College of Engineering of the University of Illinois and the Engineering Experiment Station includes C. R. Richards, B.M.E. (Purdue '90), M.M.E. (Cornell '95), for nineteen years associated with the engineering work of the University of Nebraska and for several years as professor of mechanical engineering and dean of the College of Engineering, has been appointed professor of mechanical engineering in charge of the department. A. M. Buck, M.E. (Cornell '04), for two years assistant professor of electrical engineering at New Hampshire

College, and for the past year professor of electrical engineering at the Clarkson School of Technology, has been appointed assistant professor of railway electrical engineering. F. C. Lincoln, S.B. (Mass. Inst. '00), E.M., Ph.D. (Columbia '11), for three years professor of geology and metallurgy at the New Mexico School of Mines, for three years professor of geology at the Montana State School of Mines, and for the past year in practise in New York City as consulting mining engineer, has been appointed associate in mining engineering. Paul Hanson, B.S. (Mass. Inst. '03), for several years practising sanitary engineer, has been appointed associate in sanitary engineering. G. A. Shook, A.B. (Wisconsin '07), for the past four years instructor in physics at Purdue University, has been appointed instructor in physics. J. W. Hornbeak, B.S. (Ill. Wesleyan '06), A.M. (Illinois '09), assistant in physics at Cornell University, has been appointed instructor in physics. G. A. Goodenough has been promoted from associate professor of mechanical engineering to professor of thermodynamics, and M. L. Enger from associate in theoretical and applied mechanics to assistant professor of theoretical and applied mechanics.

NEW faculty appointments to the School of Applied Science of the Carnegie Technical Schools, Pittsburgh, for 1911–12, are: Charles B. Stanton, assistant professor of railroad engineering; Clyde T. Griswold, assistant professor of mining engineering; Clinton J. Davisson, instructor in physics; Arden B. Holcomb, instructor in electrical engineering; Joseph H. Cannon, instructor in electrical engineering; H. J. MacIntire, instructor in mechanical engineering; Edgar F. Leippe, assistant instructor in machine design; O. T. Geckler, instructor in mathematics; J. A. Fitzgerald, instructor in commercial practise and statistics; Edwin C. Kemble, assistant instructor in physics; Roy B. Ambrose, assistant instructor in mechanical engineering laboratory.

MR. G. R. ANDERSON has been promoted to an associate professorship of physics, Mr. H. W. Price to an associate professorship of electrical engineering and Mr. P. Gillespie to an associate professorship of applied mechanics at the University of Toronto. Mr. T. B. Saunders has been appointed lecturer in vertebrate embryology.

DISCUSSION AND CORRESPONDENCE

COUPLING *vs.* RANDOM SEGREGATION

TO THE EDITOR OF SCIENCE: The suggestion offered by Morgan, in SCIENCE of September 22, to account for the coupling and repulsion of factors for various characters in inheritance in such forms as *Abraxas, Drosophila,* fowls, sweet peas, etc., incites this note.

Briefly Morgan's hypothesis is (1) that the materials representing factors that couple are "near together in a linear series" in the chromosomes; (2) that, when pairs of parental chromosomes conjugate, "like regions stand opposed"; (3) that "homologous chromosomes twist around each other," but that the separation of chromosomes is in a single "plane"; (4) that, thereby the "original materials will, for short distances be more likely to fall on the same side of the split," while more remote regions will be as likely to fall on one side as on the other; (5) that, in consequence, whether characters are coupled in inheritance or are independently inherited depends upon the "linear distance apart of the chromosomal materials that represent factors."

Leaving for cytologists to determine what has become of the "individuality" of the chromosomes, we may well inquire whether this hypothesis can account for the facts of Mendelian inheritance as exhibited in coupling, allelomorphism and independent segregation of the factors that represent characters. If parental chromosomes twist together and then separate in a single plane so that materials near together in a linear series are usually left together on one side of the split while more remote materials fall by chance on either side, it would seem that somewhere between these two regions the material representing some one character at least must be divided by the split so that part of it would lie on one side and part on the other. That

is, there would result a quantitative division of the material representing the character in question. This brings us back, at least so far as certain characters are concerned, squarely to the position taken by Morgan last year in his paper: "Chromosomes and Heredity" (*Amer. Nat.*, 44: 449–496).

While the hypothesis there presented, including the proposition that the plane of division of homologous chromosomes may be at any angle to the plane of union and the assumption that a certain quantity of the material representing a character must be present in order that the character develop, will doubtless account for the results (ratios) obtained in F_2 of a cross, *it certainly will not account for the purity of extracted recessives and dominants as exhibited by their behavior in* F_3 *and later generations. To overlook this is to neglect the fundamental part of Mendelism.*

A hypothesis that does not explain how extracted recessives can breed true generation after generation without the production of so much as a single individual having the dominant character will hardly be accepted by present-day students of genetics.

R. A. EMERSON

HIBERNATION

TO THE EDITOR OF SCIENCE: The *Popular Science Monthly* of October, 1910, published an article of mine entitled "The Natural History and Physiology of Hibernation," pp. 356–364. Since this article appeared some additional facts, in natural history, have been brought to my notice as well as some errors bearing on this subject. It is the purpose of this letter to note the former and to correct the latter.

On page 359 will be found the sentence: "Many butterflies and moths hibernate in the perfect state as well as in the form of imagos, but not in the larval state (?)." The correction here is that "*pupa*" should be read instead of "*imagos.*" In the latter part of the same sentence, "but not in the larval state (?)" the statement is wrong, for several butterflies and a great many moths hibernate in the larval state, notably the Noctuidæ and Arctiidæ, consequently the query mark should be abolished.

Again the statement is made, "Insects which hibernate do not pair until spring and bees do not hibernate at all." This sentence is not quite full enough and demands more detailed information or additional light on the subject. All our wild bees, wasps and some others pair in the autumn and the fertile females hibernate. Hive bees, on the other hand, pair in the spring and do not hibernate.

The statement will be found on page 360: "but curiously enough no case [hibernation] is known among birds." I must still hold to this notwithstanding the following account, which may interest your readers, furnished to me in a private communication, by Mr. C. W. Nash, biologist to the Ontario government. I quote in full: "I have found evidence (of a sort) which leads me to believe that the Purple Martin and Chimney Swift may at times become partially dormant and I have recently received from an eye-witness an account of the cutting down of a hollow tree near Peterboro, in the month of January, many years ago; this tree is said to have contained hundreds of swallows in a dormant state, some of which were revived. I have the names of other witnesses of this curious incident and am looking them up."

In support of this suggestive phenomenon one can say that we do not know what part of the world the Chimney Swift does migrate to for the winter but it would be well to remember also that we are equally ignorant of the path the Arctic Tern takes to and from its winter and summer homes, 11,000 miles apart! We are still lamentably ignorant of a great many things about birds.

Mr. Nash supports the statement on page 360 that a low temperature was not the only cause of hibernation. He experimented with Black Bass and found that when the fish were "kept in a warm room they ceased to feed at the end of October and resumed again in March, though they never became dormant—in fact were just about as active during the winter as at any other time, though in nature I do not think they are so." I trust that these

corrections and additions will prove of value to the student of natural history as well as increase the interest in the phenomenon of hibernation.

ALLEN CLEGHORN

DRAFTS AND COLDS

To the Editor of Science: Does it often happen that a writer opposes his own claims so neatly and conclusively as in "Drafts and Colds" in your issue of the 22d?

Those who read about the 16-inch fan will think of the generous third that rests upon a feather or other mattress and is correspondingly warmed while two thirds is fan-swept.

How could a more complete "disturbance of the thermo-neural equilibrium of the surface of the body" be secured and maintained?

(Other inventors prefer the cool blast from an exactly opposite direction.)

H. F. DUNHAM

September 26

"WASHINGTON SCIENCE"

The communication in Science of September 29, with the above title, signed "Washingtonian," has doubtless been read with interest by many scientific men in this city and elsewhere. However, the article contains no mention of one feature in government work which in the mind of the present writer constitutes an obstacle to scientific work and a serious defect in the plans of more than one branch of the service. This is the placing and assumption of too much executive responsibility in scientific bureaus in the hands of unscientific subordinates to the chief.

The justification for "red tape" given by "Washingtonian" should have been applied to "system." In this sense the arguments can not be successfully controverted nor is there much more necessity for system in government work than exists in many universities or business houses. The head of a scientific bureau or department, however, has no desire to give routine matters his personal attention and wisely delegates the keeping of records and accounts to a chief clerk or executive assistant known by some other title. It is, however, too often true that these subordinates overstep their original authority and gradually assume more. They may and often do become autocrats in their respective departments or bureaus. "System" then rapidly becomes "red tape." We then have the spectacle of a man without scientific training or experience dictating to the scientific corps how they shall conduct themselves.

Scientific work in an atmosphere such as this is aggravating and, while many of the annoying circumstances are too small to carry to the bureau or department head, as a whole they constitute an objection to scientific work in government service sufficient to have driven more than one good man away. A university may employ a purchasing agent or bursar, but it would, I trust, be difficult to find cases in which a department head receives practically all of his orders from such employees. In Washington it is not so difficult to find such cases. The fault has its origin in the executive's distaste for the details of system, but too often involves the whole corps in the maze of regulations made by men who have nothing else to do and who hunger and thirst for authority. In view of these actually existing conditions the writer may perhaps be excused from openly currying disfavor with the real powers by signing himself merely

ANOTHER WASHINGTONIAN

CHANGES IN THE PERSONNEL OF THE INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

The members of the International Commission on Zoological Nomenclature have unanimously invited Professor K. Kraeplin, Direktor des Naturhistorischen Museums, Steinthorwall Hamburg, Germany, to serve on the commission until the next International Congress, in the place of Professor Maehrenthal, deceased; also Dr. P. Chalmers Mitchell, secretary Zoological Society of London, Regent's Park, London, N. W., in the place of Dr. Boulenger, resigned.

CH. WARDELL STILES,
Secretary

October 10, 1911

QUOTATIONS

A LABORATORY FOR EUGENICS

We publish this morning, and commend heartily to our readers, a very cogent appeal issued by the Francis Galton Laboratory Committee with the approval of the senate of the University of London, and signed by Lord Rosebery, the chancellor, Sir William Collins, the vice-chancellor, Sir Edward Busk, the chairman of convocation, Dr. Miers, the principal, and other members of the committee, asking for contributions towards a sum of £15,000 which is required in order to build the Galton Laboratory for eugenics. It will be remembered that the late Sir Francis Galton bequeathed the residue of his estate, amounting to about £45,000, to the university for the purpose of encouraging the study of National Eugenics, and that he expressed his hope that the university would see fit to preserve the capital wholly or almost wholly intact, not encroaching materially upon it for cost of building, fittings or library. This wish has been strictly respected, and the work of Professor Karl Pearson and his assistants has been conducted under great disadvantages in rooms wholly unsuited for the purpose, although with a vigor and efficiency of which ample evidence has been afforded by some of the controversies to which it has already given origin. The scheme now put forward on the part of the committee would provide a building adequate at least for present needs, on land given for the purpose by the university, and would provide for the safe stowage and the ready accessibility of the numerous pedigrees and other records which are being accumulated in excess of the power of examining and applying them. The committee point out in their appeal that future legislation is likely to deal largely with social problems, and declare it to be essential that the statistical facts on which such legislation may be based shall be analyzed in a purely scientific manner by workers who can give time and energy to investigation, quite independently of any ulterior end or party bias; and they are able to declare that a wide interpretation has already been placed upon Sir Francis Galton's recorded wish that the laboratory "should provide information, under appropriate restrictions, to private individuals and to public authorities." They tell us that they are at present in possession of material, received from educational and health authorities in all parts of the country, which alone would afford three or four years of continuous labor for the existing staff, and the bulk of which has direct bearing upon the most important social and national problems of the day.—London *Times*.

SCIENTIFIC BOOKS

Hygiene and Public Health. By Louis C. Parkes, M.D., D.P.H., and Henry R. Kenwood, M.B., F.R.S. Edinburgh, D.P.H. London. Philadelphia, P. Blakiston's Son & Co. 1911. 8vo. Pp. 691. Fourth edition with 86 illustrations.

The fourth edition under the conjoint authorship of this work which had previously run through five editions has been carefully revised and brought up to date and will meet the needs of the practitioner and student in a most satisfactory manner. The book contains thirteen chapters, and treats in a very comprehensive manner the following subjects: (1) Water, (2) The Collection, Removal and Disposal of Excretal and other Refuse, (3) Air and Ventilation, (4) Warming and Lighting, (5) Soils and Building Sites, (6) Climate and Meteorology, (7) Exercise and Clothing, (8) Food, Beverages and Condiments, (9) The Contagia-Communicable Diseases and their Prevention—Hospitals, (10) School Hygiene, (11) Disinfection, (12) Statistics, (13) Sanitary Law and Administration.

In the chapter on Water we note with approval the authors' comments on "domestic filters, which are probably more often a source of pollution of the water than otherwise. It is usually considered that a filter requires no attention; it is consequently but rarely cleaned; the filtering material is seldom renewed and its pores become clogged with putrescible organic matter, which form a suitable nidus for the growth and development of living organisms which contaminate the filtered water. It is not unusual under such circumstances to find a considerably larger proportion of organic matter in the filtered

water than was present before filtration." These remarks are especially applicable to so-called gravity filters in which the filtering material is composed of vegetable or animal charcoal, sand, spongy iron, magnetic carbide of iron, polarite and carferal, the latter substance being a mixture of iron, charcoal and clay. It should be distinctly understood that there is no such a thing as a self-cleaning filter and even the Pasteur-Chamberland, Berkefeld and filters of the type in which the water is passed under pressure through hollow porous porcelain cylinders require periodical cleaning at short intervals by a hard brush—otherwise bacteria may in time grow through the cylinder and appear in the effluent; while it has been shown by Dr. Horrocks that the typhoid organisms are not able to grow through the walls of the Pasteur-Chamberland candle, they can grow through the walls of the Berkefeld candles "probably owing to the larger size of the lacunar spaces" and hence the Berkefeld candles should be sterilized in boiling water every third day. On the whole, we may conclude that it is clearly the duty of every community to supply a pure wholesome water, so that domestic filtration may not be necessary.

Among the diseases believed to be produced by impure water the authors refer especially to dyspepsia, dysentery and diarrhœa, typhoid fever, cholera and a number of entozoal infections. The relations of water to goiter and cretinism require further researches. In yellow fever, diphtheria, urinary calculi and rickets, formerly believed to be influenced by the drinking water, the evidence is so indefinite that the water theory has been generally abandoned. Recent observations by Schroeder, of the Department of Agriculture, and others indicate that the germs of tuberculosis are frequently present in the alvine discharges of tuberculous animals and man and by sewage pollution may thus infect the water supply.

Every sanitarian will heartily endorse the authors' chapter on the collection, removal and disposal of excretal and other refuse, because "the public health largely depends on the efficiency with which refuse matters and especially human excretal refuse, are removed from towns; the health of towns in this country and abroad has very much improved, and the death rates have been permanently lowered, as the results of works of sewerage. . . . The pail system is undoubtedly the best for towns which will not enforce the adoption of water closets. In the case of Nottingham, where middens, pails and water-closets are in use in different parts of the town, Dr. Boolbyer has shown that the greatest prevalence of enteric (typhoid) fever is to be found in the houses with middens, and the least in the water-closeted houses, those with pails occupying an intermediate position."

The chapter on Air and Ventilation deals very fully with this important subject. Recent researches clearly reveal that neither an excess of CO_2 or a deficiency of oxygen were responsible for the effects of so-called vitiated air so long as the temperature and humidity of the air were kept low. As soon as the temperature and humidity were increased beyond certain limits there appeared, both in normal and in diseased persons who were submitted to experiment, the usual symptoms that occur when people are crowded together in one room —" *i. e.*, feelings of drowsiness and headache, oppression, lassitude, giddiness, nausea, etc. These symptoms, however, could be relieved at once simply by reducing the temperature and humidity of the air to normal and they may be attributable to heat retention."

In summing up the discussion the authors suggest the importance of "additional research to ascertain the organic constituents (if any) of expired air and to differentiate them from the volatile products of decomposition arising from the general surface and other parts of the body. . . . It may, however, be the fact that whilst nothing of any importance is given off to the air by human respiration and transpiration, yet the air by such means is deprived of some vital element, with which we are unacquainted, and without which the highest state of bodily health and efficiency can not be maintained."

The causal relation of impure air to so-

called acute and chronic crowd poisoning has been recognized for years, and the effects of limited air space upon the undue prevalence of tuberculosis have been repeatedly observed in barracks, prisons, tenement houses, etc., and it is gratifying to be told that "at the present time, other conditions such as food, exercise, etc., remaining much the same, but more air-space and better ventilation having since been provided, the death rate from phthisis is considerably less amongst these servants and prisoners of the state than amongst the civil population."

In another part of the book (p. 456) the authors, in discussing the subject of tuberculosis and the principal predisposing causes, adduce statistical data gathered at Salford and supplied by Dr. Tatham indicating the rôle which "overcrowding" and foul air play in promoting the prevalence of this disease. "Thus, in districts where *all* the houses were built on the vicious system known as 'back to back' the phthisis death rate was 5.2 per 1,000 living; where 56 per cent. of the houses were so built, the rate was 3.6; where 23 per cent. only were so constructed, it was further reduced to 3.3; and lastly where there were *no* 'back to back' houses—that is to say, where all the houses were provided with some means of light and air both in front and to the rear—the rate was only 2.8 per 1,000. These results are all the more remarkable because, with the exception of the absence of means for thorough ventilation, the back to back houses on the whole were, in Dr. Tatham's opinion, in better sanitary condition than the other houses. Similar results have been obtained by other observers and by Dr. Darra Mair, of the Local Government Board (see Report of Medical Officer of the Local Government Board, 1908–9, p. xix)."

Space will not permit to refer in detail to the excellent chapters on Warming and Lighting, Soils and Building Sites, the Hygiene of Dwellings, Exercise and Clothing, all of which contain valuable information of general and personal interest. In the chapter on Food, Beverages and Condiments much space is devoted to Professor Chittenden's work on "Physiological Economy in Nutrition with special reference to the Minimal Proteid Requirements of the Healthy Man." His elaborate experiments conducted with three classes of men, namely, *A*, five professional men (brain workers); *B*, thirteen United States army soldiers representative of men undergoing moderate physical work; and, *C*, a group of eight university students, all being thoroughly trained athletes and engaged daily in arduous physical exercise, have shown that health and vigor without loss of body weight, when equilibrium has once been established, can be maintained on a diet containing only from one third to one half of the proteid prescribed in the generally accepted dietary standards of Voit, Ranke, Moleschott and this without any increase and even, in some cases, with diminution in the non-nitrogenous elements of the diet. These investigations are of great economic and physiologic importance, since it involves not only a tremendous waste of expensive food material, but also a waste and loss of energy of vital forces in excessive metabolism and possibly also the accumulation of toxic waste products in the blood, which are believed to be the cause of degenerative diseases and premature death.

The authors declare that Professor Chittenden's conclusions "have been by no means universally accepted by physiologists and others interested in the construction of dietary scales, as they seem opposed to the general experience of civilized nations; and however interesting as indications of the adaptability of the human frame and functions to alterations in nutrition for comparatively short periods, the experiments were hardly of sufficiently long duration to warrant conclusions applicable to the life of a community for long periods. . . ."

We believe that there is no subject in the realm of physiology more important than the determination of reliable dietary standards. We have been extremely careful in other machines to study fuel economy and to use only those substances for the generation of force which are proper and no more than is absolutely necessary. Opposition fosters the spirit

of inquiry, and we sincerely trust that Professor Chittenden and his opponents may continue these painstaking experiments with a view of determining these vexed questions.

We quite endorse the views of the authors on the subject of food preservatives and have always maintained that the addition of chemicals should not be tolerated as long as we possess in pasteurization, sterilization, refrigeration, pickling and smoking efficient means. The book on page 354 refers to Dr. Wiley's feeding experiments in 1905–7 which demonstrated "that formic aldehyde, boric acid and salicylic acid are substances which when added to food, even in small quantities, may exercise a harmful effect on digestion and health. Few of these agents enter normally into the constitution of the human body, and at least they must be regarded as foreign bodies whose ingestion works no possible good, and which, not being foods, do not in any way make amends for the additional work of elimination which their presence demands. Moreover, they enable venders or manufacturers to deal with stale or badly prepared food, to the prejudice of the more honest tradesman."

The chapter on School Hygiene will be read with pleasure and profit by all who are interested in the prevention of disease and physical defects and the prevention of permanent disabilities.

Anti-typhoid Vaccination.—In the chapter on Communicable Diseases we note the following paragraph: "The value of anti-typhoid inoculations is now obtaining general recognition. The latest report of the results of anti-typhoid inoculation in the British army in India (Army Medical Department Report, 1908) show that the attack rate in inoculated men is reduced to rather less than one half, and the case mortality to about two thirds of the rates in men who have not been inoculated. The protection conferred by two inoculations appears to be somewhat greater than that conferred by one. The material generally used for anti-typhoid inoculation is a suspension of the dead bacilli obtained from a culture killed by heat."

We have observed very much better results quoted by Major F. F. Russell, of the medical corps United States army, in *The Military Surgeon* for June, 1909. The statistics were taken from Col. Leishman's report in the *Journal* of the Royal Army Medical Corps, 1909, XII., p. 166, and indicate that for one case of typhoid among the inoculated there are ten among the uninoculated and that for one death among the inoculated there are ten among the uninoculated. Dr. Russell also refers to the results of inoculations among the expeditionary forces in German Southwest Africa reported by Dr. Mursemold, showing that the man who refused inoculation was twice as liable to have typhoid as the man who accepted and four times as apt to die of it.

It is extremely gratifying to state that the greatest triumph in the prevention of typhoid fever in military camps has been achieved by the medical corps of the United States army, as shown by the experience of the maneuver division at San Antonio, Texas, from March 10 to July 10, 1911. This division, composed of 12,801 officers and men, had one case of typhoid fever and no death, while the second division of the seventh army corps, with 10,759 officers and men, assembled at Jacksonville, Fla., during the Spanish-American war in 1898, had 2,693 cases of typhoid fever with 248 deaths. "This division," writes Col. Kean, of the medical corps, in the *Journal of the American Medical Association,* August 26, 1911, "was not conspicuously unfortunate in its typhoid record for that time and is selected because of the close similarity of its conditions of service to those of the maneuver division. The two divisions were encamped in nearly the same latitude and for about the same length of time, and each had a good camp site and an artesian water supply of unimpeachable purity."

While it is true that camp sanitation was rigidly enforced, especially as regards the disposal of wastes, no new sanitary principle was evolved, and we are forced to conclude that the protective inoculations played the most important rôle. Anti-typhoid vaccination was

introduced into the United States army largely through the efforts of Major Russell, of the Army Medical School, and was made compulsory for the officers and men of the maneuver division. Dr. Russell recently wrote me that over 45,000 of our troops have now been vaccinated without any untoward results. He says: "This is the first time in the history of preventive medicine that compulsory immunization against typhoid fever has been used, and no military camps have ever been so free from this disease."

We have given considerable space to the presentation of this subject, not only because it is a distinct triumph for American preventive medicine, but the lessons taught should be applied in civil practise so as to avert a needless sacrifice of life and money from one of the so-called preventable diseases.

Geo. M. Kober

Georgetown University

Evolution. By J. Arthur Thomson and Patrick Geddes. No. 14 in the Home University Library of Modern Knowledge. New York, H. Holt & Co. 1911. Pp. 256. Price, 75 cents.

Another successful collaboration by the two well-known biological writers, Professors Geddes and Thomson, has produced a small but stimulating volume, "Evolution," which is the fourteenth in the new English-American series called, rather heavily, the Home University Library of Modern Knowledge. The earlier collaboration by these writers twenty years ago resulted in a book, "The Evolution of Sex," that has become a biological classic.

"Evolution" is, of necessity, largely a restatement of things already frequently and variously stated. The series to which it belongs is meant for popular consumption and has a standard that determines pretty definitely the activities of its contributors. The facts and their significance, where this significance is not too uncertain, and these facts and inductions set out with some attention to interestingness as well as clearness and accuracy; these are requirements of the series. The authors of "Evolution" have, of course, no difficulty in making their volume almost a model from this point of view.

But they have been able to add color and personal character to the book, to boot. Especially in the chapter (VI.) on "Organism, Function and Environment, in Relation to Evolution," and in VII., "Evolution Theories in their Social Origins and Interactions," and VIII., "The Evolution Process Once More Interpreted," is the personal point of view revealed. And these chapters, especially, therefore, will interest "constant readers" of evolution literature.

I have lately had occasion to say, in a review of another of Professor Thomson's books, that he is a good selectionist; though not a bad one; that is, that he is not a selectionist bigot. "However," it was added, "Darwinism for him rests on, or is, mostly selection." It is of particular interest therefore, to note that in this latest personal utterance of Professor Thomson, Darwinism, or, more fairly, evolution, is less and less chiefly selection. Indeed the closing sentences in the present book—of course they are words of Geddes and Thomson, not Thomson alone—are:

> Natural selection remains still a vera causa in the origin of species; but the function ascribed to it is practically reversed. It exchanges its former supremacy as the supposed sole determinant among practically indefinite possibilities of structure and function, for the more modest position of simply accelerating, retarding or terminating the process of otherwise determined change. It furnishes the brake rather than the steam or the rails for the journey of life; or in better metaphor, instead of guiding the ramifications of the tree of life, it would, in Mivart's excellent phrase, do little more than apply the pruning-knife to them. In other words, its functions are mainly those of the third Fate, not the first: of Siva, not of Brahma.

The whole chapter of which this paragraph is the conclusion is a plea for a sort of vitalism—to misuse again, probably, a usually misused word. It is a sort of vitalism that assumes some cause, inherent in life or pertinent only to life, capable of producing a "definite variation, its branchings essentially dichotomous rather than indefinite, with prog-

ress essentially through the subordination of individual struggle and development to species-maintaining ends."

All these changes and others, in fact the most important of floral variations, the big lifts distinctive for the evolution of orders, are thus seen no longer as indefinite, and hence dependent on external selection for their guidance; but, on the contrary, as parallel and definite, since determined through the continued checking of the vegetative process by the reproductive, and thus pressed along parallel and definite grooves of progressive change. But if this be so, the importance we have been taught by Darwin to assign to natural selection becomes greatly changed—from selecting accumulating supposed indefinite variations, to that mainly of retarding definite ones, after their maximum utility has been independently reached!

Despite, or perhaps because of, the clarifying definitions of vitalism given us by Professors Lovejoy, Ritter and others, I am now come to a point where I do not know at all what vitalism means. I once had at least a personal meaning for the word. But as I note the references to Driesch and Bergson in this book of Professors Geddes and Thomson and then read their chapter—Geddes and Thomson's chapter—on "The Evolution Process Once More Reinterpreted," and see that natural selection is for them the work "of Siva, not of Brahma," I am going hereafter to think of them as vitalists! To such a misunderstanding of vitalism and vitalists can one come through persistent reading about things and persons thus catalogued!

But let no one avoid this excellent little book about evolution because of fear of taint from vitalism. Probably no one else will find any vitalism in it; the authors perhaps least of all! V. L. K.

Stanford University, Cal.

British and Foreign Building Stones. A Descriptive Catalogue of the Specimens in the Sedgwick Museum, Cambridge. By John Watson.

Under the above caption Mr. John Watson has published a compact little volume of 483 pages descriptive of a collection of building stones prepared by him and installed in the Sedgwick Museum of Cambridge, England. The collection comprises upwards of eleven hundred specimens prepared in the form of 4½ inch cubes "the sides of which are dressed in the usual style adopted for the purposes for which the stone is generally used in the region from which the specimen comes." Each specimen is accompanied by a label giving the commercial name of the stone, its stratigraphical position, name and locality of the quarry and name and address of the owner. The individual labels state the color, average chemical composition, weight per cubic foot, and crushing strength so far as data are available.

Two hundred and forty-four pages of the catalogue are, however, given up to descriptive matter in which the stones are taken up according to their geological distribution, and it is this portion which will be of greatest value to those not having immediate access to the collection.

The collection is arranged according to the geological horizons, with the exception of the igneous rocks, which are divided into plutonic and volcanic. The portion of the work relating to the rocks of Great Britain contains much interesting historical matter and observations relative to the weathering of the rocks.

No illustrations are attempted, but there is a very full index and it is evident that a great deal of discrimination has been made in getting together the collection as well as in compiling the book which deserves the name of "handbook" rather than simply "descriptive catalogue."

George P. Merrill

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA

The twelfth annual meeting of the Astronomical and Astrophysical Society of America was held in the Dominion Observatory, Ottawa, Canada, on August 23, 24 and 25, 1911. In opening the first session, President E. C. Pickering called attention to the fact that this was the first meeting of the society held outside of the United States. Welcome to Ottawa was extended to the society by Dr. W.

F. King, director of the Dominion Observatory, whose remarks were prefaced by the reading of an official welcome in behalf of the Canadian government, communicated by the Deputy Minister of the Interior, W. W. Cory, C.M.G.

Five sessions of the society were devoted to the reading and discussion of papers, to the reports of committees and to routine business. In addition the society's program was amplified by an opportunity extended the visiting members to examine the work and the equipment of the Dominion Observatory. Following this inspection a resolution was unanimously adopted as follows:

Resolved, That the Astronomical and Astrophysical Society of America, assembled at the Dominion Observatory for its twelfth annual meeting, has examined in detail the work of the observatory, and expresses its very favorable opinion of the character of the investigations carried on in all of its departments. This is particularly the case with the determinations of radial velocity, from which unusually valuable results have been obtained by means of a telescope of comparatively small size. In view of the pressing need for such data, the society hopes that a more powerful telescope may soon be provided, and one in keeping with the standing now attained by the national observatory of Canada.

Aside from the purely astronomical program of the meeting several most enjoyable social features were arranged for the members and friends present, whose appreciation was expressed in an unanimous resolution of thanks to Dr. King and his staff.

The list of members in attendance is as follows: Miss Bigelow, Miss Cannon, Miss Furness, Miss Palmer, Miss Swartz, Miss Whiting, Messrs. Apple, Bailey, Chant, Curtiss, C. L. Doolittle, Douglass, Eichelberger, Frisby, Harper, Jordan, W. F. King, Littell, Manson, Marsh, McDiarmid, J. A. Miller, Motherwell, Peters, Plaskett, Russell, Schlesinger, Slocum, Stebbins, R. M. Stewart, Tatlock, Tucker and A. B. Turner. In addition several friends of the society were in attendance.

The following eighteen persons were elected to membership: Mr. C. A. Bigger, Dominion Observatory, Ottawa, Canada; Mr. Leon Campbell, Harvard Surcursal, Arequipa, Peru; Dr. E. A. Fath, Mount Wilson Solar Observatory, Pasadena, Cal.; Mr. Alexander Sarkis Galajikian, Cornell University, Ithaca, N. Y.; Mr. Curvin H. Gingrich, Goodsell Observatory, Northfield, Minnesota; Mr. William Pratt Graham, 1205 Harrison St., Syracuse, N. Y.; Professor Thomas F. Holgate, Northwestern University, Evanston, Ill.; Mr. Louis Allen Hopkins, Ann Arbor, Mich.; Dr. Otto Klotz, 437 Alberta St., Ottawa, Canada; Mr. Carl Otto Lampland, Lowell Observatory, Flagstaff, Arizona; Rev. D. B. Marsh, Springville, Ontario, Canada; Mr. Richard John McDiarmid, Dominion Observatory, Ottawa, Canada; Mr. R. M. Motherwell, Dominion Observatory, Ottawa, Canada; Miss Margaretta Palmer, Yale Observatory, New Haven, Conn.; Mr. Harry B. Rumrill, Berwyn, Pa.; Mr. R. M. Stewart, Dominion Observatory, Ottawa, Canada; Miss Psyche Rebecca Sutton, 813 Market Street, Logansport, Indiana; Mr. Warren J. Vinton, The Wellington, Detroit, Mich.

A committee on cooperation in the teaching of astronomy was appointed with membership as follows: Professors C. L. Doolittle (chairman), Sarah F. Whiting, C. A. Chant and J. A. Miller.

The following officers were selected during the meeting:

President, E. C. Pickering; *First Vice-president*, E. B. Frost; *Second Vice-president*, W. W. Campbell; *Secretary* (for three years), W. J. Hussey; *Treasurer*, C. L. Doolittle; *Councilors* (for two years), W. S. Eichelberger, J. S. Plaskett; *Editor for the meeting*, R. H. Curtiss. The terms of office of W. J. Humphreys and F. Schlesinger as councilors did not expire at this meeting.

The next annual meeting of the society will be held at the Allegheny Observatory, Pittsburgh, in August, 1912. The society will also meet at Washington in December, 1911, in connection with Section A of the American Association for the Advancement of Science.

Papers (thirty in number) and reports read at the various sessions of the Ottawa meeting are given below in abstract.

Photographic Determination of the First Point in Aries: E. C. Pickering. (Read in connection with the symposium on Photographic Astrometry.)

Absolute positions of the stars can probably be obtained by photography, with errors no greater than those of visual determinations, if a telescope can be made to remain in a fixed position during twenty-four hours. The most favorable conditions would probably be attained by mounting the telescope underground, pointing south at an altitude nearly equal to that of the sun. Azimuth observations with meridian circles indicate, in some cases, that an entire hill has a progressive motion. This is obviously improbable in a level plain. Great pains must be taken to connect the objective

rigidly with a metal plate nearly in the focal plane and that this combination shall remain fixed. Rigidity is not required in any other parts of the apparatus. The plate has two holes illuminated by incandescent lamps which when lighted form minute points on the photograph. A circle about two centimeters in diameter is silvered in the center of the objective, whose aperture is reduced to this amount. Several exposures on the sun are made at noon automatically by the clock, moving the plate in declination after each exposure by an amount equal to the diameter of the sun. At the same time a current passes through the lamps which thus impress two reference points upon the photograph. At night the same or another plate is exposed for a second or so to the stars, using the full aperture, and the position of the trails with regard to the reference points, compared with that of the sun, gives the relative positions.

Photographs were exhibited showing images of the sun and stars upon the same plate.

The Spectra of 762 Double Stars: Annie J. Cannon.

A list was prepared of all stars in the "General Catalogue of Double Stars" by Burnham, and the "Reference Catalogue of Southern Double Stars" by Innes, in which the components are of magnitude 7.5, or brighter. A special examination of the Harvard photographs was made to determine the spectra of these stars.

Classification of some Stellar Spectra Photographed with the Slit Spectroscope at the Allegheny, Lick and Yerkes Observatories, Compared with those taken at Harvard with the Objective Prism: Annie J. Cannon.

The Draper classification of stellar spectra depends wholly on photographs taken with the objective prism. In view of the fact that a large number of photographs is being made with the slit spectroscope at various other observatories, it appears to be a matter of great importance to make a comparative study of these spectra, and to determine whether the same system of classification will apply to spectra obtained by these two widely different methods. Accordingly, a preliminary study has been made of 131 spectrograms, including spectra from Class Od to Class Md.

The Spectra and Colors of Red Stars of Harvard Classes N and R: J. A. Parkhurst. (Read by Dr. Slocum.)

In June, 1911, Professor E. C. Pickering sent the writer a list of "Fourth Type Stars not Red" (Class R). This list was extended to include an assortment of ordinary red stars (Class N). An investigation of the spectra of these stars was made from plates taken with the objective prism on the 6-inch Zeiss camera and with the Brashear spectrograph on the 40-inch Yerkes refractor. The "Color-Index" was found by comparing the photographic magnitude with the so-called "visual" magnitude obtained with color-sensitive plates and the "visual luminosity" filter, on plates taken with the Zeiss camera and the 2-foot reflector.

The paper, which will be published in full in *Astrophysical Journal,* gives results for 17 stars, for which the "color-indices" range from 1.11 to 5.60 magnitudes. The principal conclusions are:

1. Excepting the first star, which apparently has a composite spectrum, all are as red or redder than *α Tauri,* and therefore seem to deserve the name of "red" stars.

2. No sharp line can be drawn between the Classes N and R.

The Orbits of the Spectroscopic Components of d Bootis: W. E. Harper.

Fifty-three spectrograms of this F-type star, photographic magnitude 5.3, form the basis of the determination of the elements of the orbit. The plates were obtained mostly with the single-prism instrument, but for considerably over half the period of 9.60 days the spectra were separated and measures were made on each component. Elements were determined for each by the method of least-squares, after preliminary elements had been obtained graphically. These were in substantial agreement with each other; but a more rigid determination was effected by combining the observation equations of the two components into *one* set of normal equations, thereby deriving uniform values for the elements.

Studies of Bright Variable Stars: Joel Stebbins.

Observations with the selenium photometer have been continued during the past year, and the paper contains results for three stars, *α Orionis, δ Orionis* and *β Aurigæ*. *α Orionis* is a well-known irregular variable, and the results for 1910–11 indicate a range of 0.2 mag. *δ Orionis* has long been suspected of variability, but it is now shown to be an eclipsing variable with two minima, the range being about 0.10 mag. The third star, *β Aurigæ,* has also been found to be an eclipsing variable with a range of less than 0.10 mag. A combination of the photometric and spectroscopic results gives the actual dimensions of this binary

system, and the complete work will soon appear in the *Astrophysical Journal.*

The Variability of Polaris: EDWARD S. KING. (Read by Professor Stebbins.)

The variability of Polaris having been announced by Professor E. Hertzsprung, I examined the results obtained by photographing stars out of focus, contained in Nos. 4, 5 and 6 of H. A. 59, to discover what evidences of such changes might be afforded.

The corrections given for the individual plates were used to show changes in Polaris for the different nights. The spectroscopic period, 3.9683 days, was accepted. A separate grouping according to phase was made for each of the three investigations. The light curves derived from these three independent series of observations are all of practically the same form and amplitude as Hertzsprung's, and confirm his discovery. The curve derived from Nos. 5 and 6 of H. A. 59 suggested a sine curve. And such a curve was found to represent the ten points given by the grouping. A sine curve having an amplitude of 0.108 mag. is a very close approximation. The residuals, expressed in thousandths of a magnitude, for the ten points are + 6, + 2, — 9, + 6, + 8, — 4, — 6, + 5, — 7 and + 3. The average deviation is ± 0.0056.

The effect of the variability of Polaris on the magnitudes already determined by the out-of-focus method was practically eliminated by the nature of the reduction employed in the original work. Corrections were made which included any variation in the light of Polaris, or any change in the conditions occurring between photographing Polaris and the stars observed. The effect was the same as if Polaris had been known to be variable.

No special plates or measures have been made to obtain the above results. All the material has been derived from matter already in type.

A Study of Visual Binary Stars: HENRY NORRIS RUSSELL.

1. The masses of visual binary systems computed from their observed parallaxes vary through a wide range, as Aitken has recently shown. But if "hypothetical" parallaxes are computed on the assumption that the mass of each of these systems is 2.4 times that of the sun (the average for the twelve best determined systems) only five out of 26 observed parallaxes differ from these hypothetical values by quantities greater than might be expected in view of the probable errors of the former. The average difference between the observed and hypothetical parallaxes in the twelve best determined cases, corresponds to a probable error of only one fifth of the latter (including all errors of observation). It is evident that the binary stars are much alike in mass, and that the assumption of equal masses gives very good approximations to the true distances, etc., of these systems.

2. It is well known that a relation between the density P and the surface brightness J of a binary star can be obtained independent of its parallax. Let M and L be the actual mass and luminosity (the sun being standard), r the radius, π the parallax and l the apparent brightness (in suitable units). Then (assuming a single mass)

$$L = Jr^2 = \frac{l}{\pi^2}; \quad M = \rho r^3 = \frac{a^3}{\pi^3 t^2};$$

whence

$$\rho J^{-\frac{3}{2}} = ML^{-\frac{3}{2}} = \frac{a^3}{t^2 l^{\frac{3}{2}}}.$$

The values of $\rho J^{-3/2}$ for the individual components may be found when the ratios of their masses and luminosities are known, and (as experience shows) estimated with sufficient accuracy for the brighter component from the observed difference in magnitude.

Applying this to 83 binaries (the spectra of 29 of which, determined by Mrs. Fleming and Miss Cannon, were very kindly furnished the writer by Professor Pickering) it is found that the whiter stars are very much brighter for equal masses than the redder ones, while the stars of any one spectral type are much more similar in brightness.

The average masses of 73 of these binaries were determined by means of their parallactic motions on the assumptions (1) that the stars of a given spectral type are of equal mass; (2) that they are of equal luminosity. The two sets of values agreed closely, showing both methods to be equally legitimate.

3. For most "physical pairs," shown to be so by common proper motion, only the apparent distance and the rate and direction of the apparent relative motion are at present known. The masses, and related quantities, for the average of groups of ten or more such stars, can be found by a statistical process. Let r be the true distance, and V the true relative velocity in space; a the major axis of the orbit; s the observed distance, and w the observed relative velocity, as projected on the celestial sphere; i_1 and i_2 the angles between r and v and the line of sight; M the mass and π the parallax of the system.

Then $s = r\pi \sin i$, $w = v\pi \sin i_2$, and by gravitational theory

$$v^2 r = K^2 M \left(2 - \frac{r}{a}\right),$$

where the constant K^2 is 39.7 of the sun's mass; the astronomical unit and year are taken as units. Hence

$$\frac{sw}{\pi^3} = 39.7 M \sin i \sin^2 i_2 \left(2 - \frac{r}{a}\right).$$

The last three factors are unknown, but their average values can be predicted on principles of probability. This gives the formula

$$M = \frac{sw^2}{18\pi^3}. \qquad (1)$$

The average of the values given by (1) for a large number of stars will be practically correct. The percentage of individual cases in which the error of this formula may be expected to lie between given limits has been calculated, showing that the mean derived from ten cases will probably be within 10 per cent. of the truth.

4. This method has been applied to all available physical systems brighter than the sixth magnitude, 276 in all, raising the whole number of stars discussed to 349. All the principal spectral types are well represented.

For about half these stars, the relations between mass and surface brightness are very similar to those already found among stars for which orbits have been computed. The other half (including all the stars of type B and some of every other type) are *very much brighter in proportion to their mass* than those previously studied. These stars are probably similar to the stars of great luminosity to which Hertzsprung has called attention under the name of "giant stars." The others may be called "dwarf stars." In type A the two kinds run together, but among the redder stars they are more and more widely separated, though a few intermediate cases exist.

Among the giant stars the relation of mass and brightness is much the same for all spectral types, the values of $\rho J^{-3/2}$ ranging from 0.004 to 0.002 (the sun being the standard). Among the dwarf stars the brightness falls off very rapidly with increasing redness. $\rho J^{-3/2}$ being 0.03 for type A, 0.30 for F, 1.2 for G, 4.8 for K, and rising to over 2,000 for certain faint stars of large parallax whose spectra appear to be of types K_5 or M (with the exception of one aberrant star of type A).

5. The average masses of the giant and dwarf stars of each spectral type have been determined from the parallactic motions (assuming constant luminosity for the stars of each group 25 to 60 in number).

All the giant stars appear to be similar in mass —a system of this sort having about 10 times the mass of the sun. The average masses of the dwarf stars decrease with increasing redness —that of a system of type F being some three times the sun's mass, and of one of type K rather less than the sun's.

The average light emission of a pair of giant stars is from 150 to 250 times that of the sun (the latter for type B). That of the dwarf stars diminishes from 30 for type A to 4.5 for F, 1.3 for G, 0.3 for K and 0.01 for the faint stars already spoken of. It appears therefore that the more massive stars are by far the brightest.

6. The average densities of stars of types B, A and F can be found with the aid of Algol-variables of these types, and the surface brightness may then be deduced from the values of $\rho J^{-3/2}$ already found.

Allowing for the fact that in the average Algol-variable the brighter star is decidedly the smaller of the two, the following values are found—those for type F being uncertain, and the sun being throughout the standard.

	Giant Stars			Dwarf Stars	
	F	*A*	*B*	*A*	*F*
Density	0.04?	0.09	0.13	0.45	0.6?
Surface brightness	4.5?	7.2	15.0	6.1	1.7?

The very faint stars of spectra K_5 and M, even if of ten times the sun's density, can not exceed 1/30 of its surface brightness.

These values agree closely with those derived from the work of Wilsing and Scheiner on stellar temperatures (based on the distribution of energy in the spectrum).

They afford an independent confirmation of the hypothesis that the effective surface temperature of a star is the principal factor which determines its spectral type.

7. Assuming that the surface brightness of giant and dwarf stars of the same spectral type is the same (and interpolating values for spectrum K with the aid of Wilsing and Scheiner's results) it is found that the mean density of the giant stars increases steadily with *decreasing* redness from less than 1/10,000 that of the sun for type M, and 1/1,000 for type K, to 1/8 for type B. That of the dwarf stars increases with *increasing*

redness, the average density for types G and K being about that of the sun.

8. It may be added that all these facts (except the existence of one very faint star of type A) are in harmony with the scheme of stellar evolution sketched by the writer last year.

The 6-inch Transit Circle of the U. S. Naval Observatory: F. B. Littell.

Work has been begun with this instrument on a list containing the old or historical fundamental stars, and the new fundamental stars as proposed by the International Committee of the Photographic Chart of the Sky. The instrument is fairly satisfactory as to its errors, which are either quite constant, or are readily determined for any instant by interpolation between values observed at suitable intervals. The pivots have been measured with great accuracy by the axial microscope method. Their irregularities are very small. The division errors of the degree lines of circle A have been determined, also the periodic errors of the two-minute lines within the ten-minute spaces. The periodic and progressive errors of the telescope micrometers and of the microscope micrometers have been measured.

The zenith distance micrometer is used for declination work. Readings are made on two circle divisions under each of the four microscopes, using two pairs of threads in each, distant 2.5 revolutions of the micrometer screw from each other. A hand-driven self-registering right ascension micrometer is used. A reversing prism is used, by means of which each observation is taken half with image direct and half with image reversed. The instrument is reversed from clamp east to west and *vice versa* at short intervals.

In order to test the performance of the instrument a list of 30 stars was observed 4 times in each of 8 positions of the instrument; *i. e.*, direct and reflected (D.R.), clamp east and west (E.W.), and with objective and eye-end interchanged (I., II.). Circle A was used in fixed position, and circle B was shifted each night. The level errors were determined from nadir observations.

Right Ascension.—By a discussion of the differences E.–W. and R.–D. the following flexures were wound:

Lateral flexure varying as cos $2z$

$$+ 0^s.005 \pm 0^s.001 \text{ (DEI)}$$

Axis flexure varying as cos $2z$

$$- 0^s.025 \pm 0^s.002 \text{ (DEI)}$$

The following tables show the quantities indicated before and after the application of the corrections due to the above flexures.

	Azimuth of Marks			
	North Mark		South Mark	
	Observed	Corrected	Observed	Corrected
	s	s	s	s
Clamp E. I.	−0.055	−0.018	+1.040	+1.077
" W. I.	+ .010	− .027	+1.132	+1.095
" E. II.	− .067	− .030	+1.049	+1.086
" W. II.	+ .022	− .015	+1.132	+1.095

In the next table each quantity is the mean for 3 stars and each has been multiplied by cos δ.

	Right Ascension Uncorrected for Flexure											
	½ (D–R)				½ (W–E)				½ (II–I)			
2 DS	E, 1	W, 1	E, 11	W, 11	D, 1	R, 1	D, 11	R, 11	E, D	E, R	W, D	W, R
	s	s	s	s	s	s	s	s	s	s	s	s
+55°	+.006	+.012	−.005	+.001	−.001	−.007	+.004	−.002	−.010	+.001	−.007	+.007
49	− 1	+ 17	− 12	+ 15	+ 6	− 12	+ 20	− 7	− 9	+ 2	+ 4	+ 7
44	− 4	+ 4	0	+ 8	0	+ 3	+ 2	− 6	0	− 5	+ 3	− 2
27	+ 3	− 4	+ 4	− 1	− 5	+ 2	− 4	+ 1	+ 4	+ 3	+ 5	+ 3
+12	− 4	− 9	+ 2	− 13	+ 7	+ 12	+ 8	+ 22	+ 2	− 4	+ 3	+ 6
−11	+ 3	+ 3	+ 3	− 5	+ 8	+ 8	+ 8	+ 15	+ 5	+ 5	+ 4	+ 12
20	− 3	+ 6	− 8	+ 2	+ 2	− 7	+ 16	+ 6	− 1	+ 5	+ 15	+ 17
32	− 11	+ 4	− 12	− 2	+ 13	− 2	+ 25	+ 16	0	0	+ 12	+ 17
46	− 17	+ 24	− 11	+ 19	+ 26	− 16	+ 33	+ 2	+ 6	0	+ 14	+ 17
−58	− 22	+ 32	− 25	+ 30	+ 32	− 22	+ 39	− 15	0	+ 4	+ 8	+ 8

By the application of the flexure corrections the probable error of a single observation in right ascension is reduced from 0.0266 sec. δ to 0.0204 sec. δ. For direct observations it is reduced to 0.0190 sec. δ.

The above error is entirely eliminated from the mean of an equal number of clamp east and clamp west observations.

The following table gives the comparison with the right ascensions of Newcomb (N), and those of Boss (B), tabulated as above.

Declination.—From measures on the collimators and from a discussion of the observed declinations in different positions of the instrument the following corrections were determined. Some confirmatory results from short series of direct and reflected observation taken in 1909 are also tabulated.

Dn is a constant correction to reduce direct observations of north stars to the mean of direct

	Circle A			Circle B		
	D-R	W-E	II.-I.	D-R	W-E	II.-I.
Uncorr'd for flexure	0″.60	0″.34	0″.30	0″.54	0″.43	0″.40
Corr'd for flexure...	0.22	0.23	0.26	0.30	0.37	0.38

The probable error of a single observation is reduced from 0″.62 to 0″.34 for circle A and from 0″.58 to 0″.44 for circle B.

	Right Ascension, Corrected for Flexure							
	½ (D-R)				½ (W-E)			
Z. D.	E, 1	W, 1	E, 11	W, 11	D, 1	R, 1	D, 11	R, 11
	s	s	s	s	s	s	s	s
+55°	+.011	+.007	.000	—.004	—.003	+.001	+.002	+.006
49	+ 3	+ 13	— 8	+ 11	+ 4	— 5	+ 18	0
44	— 1	+ 1	+ 3	+ 5	— 2	+ 7	0	— 2
27	+ 1	— 2	+ 2	+ 1	— 4	— 1	— 3	— 2
+12	— 11	— 2	— 5	— 6	+ 10	+ 2	+ 11	+ 12
—11	+ 1	+ 5	+ 1	— 3	+ 4	+ 1	+ 4	+ 8
20	+ 1	+ 2	— 4	— 2	— 7	— 8	+ 7	+ 5
32	+ 3	— 10	+ 2	— 16	— 6	+ 7	+ 6	+ 25
46	+ 5	+ 2	+ 11	— 3	0	+ 2	+ 7	+ 20
—58	+ 4	+ 6	+ 1	+ 4	+ 2	+ 1	+ 9	+ 8

Coefficients of		Circle A. 1910	Circle B. 1910	Circle A. 1909
sin *z*, I.	From colls.	+ 0″.33 ± 0″.03	+ 0″.27 ± .03	
sin *z*, I.	" star obs.	+ .45 ± .05	+ .51 ± .05	+ 0.36
sin *z*, II.	" colls.	— .13 ± .03	.00 ± .03	
sin *z*, II.	" star obs.	+ .31 ± .05	+ .44 ± .05	
cos *z*, II.	" " "	+ .07 ± .02	+ .13 ± .02	+ .01
cos *z*, II.	" " "	+ .17 ± .02	+ .09 ± .02	
cos 2*z*	" " "	+ .18 ± .02	+ .09 ± .02	+ .10
Dn		— .21 ± .03	— .23 ± .03	— .24
Ds		— .28 ± .03	— .16 ± .03	— .11

Z. D.	Right Ascension	
	OBS.—N	OBS.—B
	s	s
+ 55°	+ 0.020	— 0.008
49	+ .030	+ .015
44	+ .009	+ .008
27	— .005	.000
+ 12	+ .004	— .006
— 11	— .001	— .004
20	+ .000	— .005
32	— .010	— .011
46	+ .009	+ .009
—58	+ .003	+ .004

and reflected, and *Ds* is a similar correction for south stars.

By the application of the corrections due to the flexures, etc., as determined from the observations, the following improvements are made in the mean differences taken without regard to sign:

Z. D.	Circle A—Boss		Circle B—Boss		Boss—N
	All Obs.	Direct Obs.	All Obs.	Direct Only	
+ 55°	+ 0″.30	+ 0″.74	+ 0″.27	+ 0″.67	— 0″.35
49	+ .16	+ .71	+ .05	+ .48	— .33
44	+ .31	+ .96	+ .23	+ .66	— .21
27	+ .37	+ .75	+ .39	+ .77	— .36
+12	+ .48	+ .76	+ .35	+ .55	— .24
— 11	+ .17	+ .32	+ .31	+ .48	— .19
20	+ .40	+ .50	+ .34	+ .49	+ .02
32	+ .39	+ .44	+ .35	+ .40	+ .13
45	+ .13	+ .11	+ .17	+ .07	— .09
— 58	+ .04	+ .05	+ .05	+ .08	+ .05

All of the cosine flexures considered above are completely eliminated from the mean of an equal number of clamp east and clamp west observations. The following table gives comparisons with the declinations of Boss, and the reduction from Boss to Newcomb. The direct observations were re-

duced with the sine flexure determined from the collimators. The corrections $\Delta\phi = +0''.2_0$ for circle A and $+0''.14$ for circle B, based on direct observations of circumpolars observed at both culminations have been applied.

The Alt-azimuth Instrument of the U. S. Naval Observatory: F. B. LITTELL.

The telescope of this instrument is of 5 inches aperture and 50 inches focal length. The graduated circle is 23 inches in diameter, read by 4 microscopes magnifying 30 times. Two levels are used on the alidade. For stars at more than 10° zenith distance, the Pulkova vertical circle method has been used in observing the declinations of stars. For stars at less than 10° zenith distance, the instrument has been used in the meridian, and a double observation has been secured by bisecting with the micrometer at a side thread before and after reversal about the vertical axis.

The essential differences between the use of this instrument for declinations and that of a meridian circle are: (1) that the double zenith distance of the object is measured; (2) that each observation is complete in itself and does not depend on the stability of the instrument except for the short interval, 5 or 6 minutes, covered by the observation; (3) that cosine flexures are immediately eliminated; (4) that spirit levels are substituted for the mercury horizon in determining the reference point of the circle, and (5) that in the Pulkova method a time observation is substituted for a micrometer observation. This latter method, however, may be adapted to meridian circle work by slightly inclining the zenith distance thread, and it has been thus used by some observers.

In general the differences seem to be favorable to the use of the vertical circle and it is probably the best type of instrument yet devised for obtaining fundamental declinations. The use of the micrometer to obtain additional bisections may lead to the securing of greater accuracy.

About 5,000 observations made by the writer from December, 1903, to July, 1907, have been reduced. One of the levels used in the early part of the work did not give satisfactory results, but for the last 3 years of the work, the levels performed in a fairly satisfactory manner. During that period the element of probable error due to levels (mean of two) in a declination resulting from a single observation was $0''.035$.

The division errors were not measured, but their effect was reduced by reading on two divisions under each microscope and by shifting the circle. The probable error of a single observed declination due to division error is $0''.15$

The sine flexure was measured in 1910 after the installation of horizontal collimators. From 14 sets of measures the value $+0''.79 \pm 0''.063$ has been adopted.

The variation of latitude as given by the International Geodetic Commission has been applied.

From 1,190 observations on 134 circumpolar stars at both culminations, the following correction to the latitude, $\Delta\phi$, and correction to the refraction constant, ΔR, were obtained:

$$\Delta\phi = +0''.50 \pm 0''.090,$$
$$\Delta R = -0''.22 \pm 0''.056.$$

As the separation of $\Delta\phi$ and ΔR was not well determined, it was assumed that $\Delta R = 0$ and the resulting value $\Delta\phi = +0''.15 \pm 0''.017$ was adopted.

The accidental error of a single observation, not including division error, is shown in the following table:

Z. D.	No. O B S.	Probable Error
0°–10°	766	± 0″.284
10 –30	1496	.243
30 –50	1340	.276
50 –70	1220	.335
70 –75	328	.465

On account of the construction of the instrument, it is difficult to observe stars near the zenith and this probably accounts for the larger probable error of stars from 0° to 10° as compared with those from 10° to 50° zenith distance.

Z. D.	No Stars	Obs. N	Obs. B
285°–290°	42	−0″.03	+0″.03
290–300	54	− .08	− .06
300–310	22	− .12	− .20
310–320	27	− .17	− .10
320–330	60	+ .35	+ .31
330–340	68	+ .02	+ .07
340–350	69	− .20	+ .11
350– 0	102	+ .05	+ .32
0– 10	96	+ .22	+ .58
10– 20	114	+ .31	+ .56
20– 30	113	+ .30	+ .53
30– 40	115	− .01	+ .34
40– 50	100	+ .23	+ .57
50– 60	89	+ .41	+ .72
60– 70	71	+ .32	+ .47
70– 75	15	+ .42	+ .52

The comparisons of the observed declinations with those of Newcomb (N) and those of Boss (B) after the application of the corrections for

sine flexure and $\Delta\phi$ are as follows. The signs have been changed for sub-polars.

In addition to the above observations there are about 2,500 made by Mr. Geo. A. Hill and Mr. H. B. Evans from 1898 to 1903, which are nearly reduced. A preliminary survey indicates the following relative personal equations for declinations of the south stars:

$$\text{H–L} = -0''.2,$$
$$\text{E–L} = -0''.4.$$

Some experimental work to clear up this matter will be undertaken before combining these observations into a catalogue.

The Earth's Radiation Zones: W. J. Humphreys. (Read by Professor Eichelberger.)

Since heat may be transferred from one object to another only by conduction, convection or radiation, therefore by measuring the temperature of the isothermal region of the atmosphere, in which both conduction and convection are small, it is possible to determine the radiation intensity of the earth at as many places as one may wish.

The effective radiating level, as determined by Abbot and Fowle, has an average elevation of about 4 kilometers, consequently the lower clouds are within the radiating surface while the cirri are above it. Hence the latter, and they alone, can strongly affect the intensity of the outgoing radiation.

An extensive exploration of the upper atmosphere with sounding balloons has shown that, probably because of the unequal distribution of cirri, the intensity of the earth's escaping radiation within the tropics is to that of latitudes 35° to 60° approximately as 3 to 4. In fact, as a radiator the earth has an inefficient equatorial zone, efficient zones of middle latitudes, and finally, for which there is some evidence, inefficient polar caps.

The Amount and Vertical Distribution of Water Vapor on Clear Days: W. J. Humphreys. (Read by Professor Eichelberger.)

It is important to any one using a bolometer, or a pyrheliometer, to know the approximate amount of water vapor through which the radiation reaching his instrument has passed. In attempting to determine this amount the records have been brought together of 74 balloon flights, made on cloudless days, or such as were adapted to the ordinary use of the bolometer.

According to these data the amount of water vapor per unit volume decreases with elevation on *cloudless* days in an approximate geometric ratio, and the thickness of the water layer that would result from a condensation of all the water vapor in the atmosphere on such days above any given level may be approximately expressed by the equation

$$d = 2e,$$

in which d is the depth of the water layer in millimeters, and e the partial pressure of the water vapor, at the place of observation, in millimeters of mercury. This value is about 13 per cent. less than that given by Hann for all sorts of days, and heretofore commonly used in bolometric work.

Daytime Laboratory Work in Astronomy: Sarah F. Whiting.

The list of members of this society includes those responsible for the teaching of astronomy in more than fifty colleges and universities. It seems therefore in order that the society should take cognizance not only of the research work by which knowledge is increased, but also of the teaching by which it is diffused.

From not very detailed information it seems probable that the methods of teaching generally used in elementary classes are not those of the other sciences.

Daytime laboratory work in astronomy by the students themselves requires a teaching force, an equipment of instruments and photographs, and a place for the work, which has not yet been demanded by the departments of astronomy nor provided by the institutions. No less research work should be done by the observatories, but the teaching should not be allowed to suffer. Useful apparatus and photographs which are the material for daytime work will never be provided by dealers in apparatus till a sufficient number of institutions adopt modern methods of teaching to make a demand for such material. Also larger numbers of students should take an elementary course in astronomy to lessen the deplorable ignorance which exists.

Other learned scientific societies have lent valuable aid to the advancement of elementary teaching. May it not be for the advancement of astronomy for this society to consider the teaching of those beginning classes from which the professional astronomers and the patrons of the observatories must come?

On Scales of Intensity for the Lines of the Solar Spectrum: Frank W. Very. (Read by Mr. De Lury.)

A spectral line not appreciably broader than an image of the slit, and perfectly black, may be

rated as 10 on an absolute scale of intensity, and the strength of any line in absolute units is the product of its width by the intensity of its absorption, multiplied by a constant. The constant may be chosen so that unity coincides with Rowland's unity, and it is found that in this case the above definition is very closely fulfilled, although Rowland's numbers diverge considerably in other parts of the scale.

From a smooth curve which represents the true photometric intensities of ultra-violet lines on negatives by Higgs, the significance of Rowland's symbols has been found to be as follows:

$R_{0.1} = 0000 = .05$	$R_1 = 1.05$	$R_6 = 10.60$	$R_{11} = 21.40$
$R_{0.2} = 000 = .15$	$R_2 = 2.57$	$R_7 = 12.80$	$R_{12} = 23.55$
$R_{0.3} = 00 = .25$	$R_3 = 4.30$	$R_8 = 14.95$	$R_{13} = 25.70$
$R_{0.4} = 0 = .35$	$R_4 = 6.30$	$R_9 = 17.05$	$R_{14} = 27.85$
	$R_5 = 8.40$	$R_{10} = 19.20$	$R_{15} = 30.00$

These values have been confirmed by measures in the green.

It is shown that, in general, the relation between the width and the intensity of the photographic images of spectral lines is not as simple as has been assumed. It is also shown that differences of width of spectral lines have been exaggerated in Thollon's Atlas, doubtless in order to convey a more realistic impression of the intensities.

Periods of Variable Stars in the Small Magellanic Cloud: Henrietta S. Leavitt.

(Read by Professor Russell.)

The periods of 25 of the variable stars in the Small Magellanic Cloud have been determined, and have been found to vary in length from 1.25336 days to 127.0 days, while the light curves are of the cluster, sometimes called the "antalgol" type. The brightness and the length of the period are so closely related that if one is known, the approximate value of the other may be inferred. For an increase of one magnitude in brightness at maximum or minimum, the logarithm of the period increases by about 0.48. It seems possible that all these variables are of similar mass, those whose periods are long having slight densities, and *vice versa.* On account of their faintness, it is impracticable to obtain their spectra, with our present facilities. A number of brighter variables having similar light curves, as UY Cygni, are in isolated positions, and should repay careful study not only of their spectra, but, if possible, of their parallaxes. Among other questions suggested are the following:

1. Are there definite limits to the mass of variable stars of the cluster type?

2. Does the spectra of such variables having long periods differ from those of variables whose periods are short, and how?

The Radial Velocities of 96 Herculis: S. A. Mitchell.

Preliminary results from the measures of twenty-five spectrograms of 96 Herculis taken with the one-prism Bruce spectrograph of the Yerkes Observatory show the presence of four components and a period of 50.2 days. On account of the large velocities, which range on the plates measured from -98 kilometers per second to $+74$ kilometers per second, it was possible to measure three separate components on half the plates, and four components on a few of them. The components all belong to the B-type.

This interesting system will be followed closely, and more definite results will be given when more plates are obtained.

The San Luis Observatory of the Carnegie Institution: R. H. Tucker.

The first part of the expedition sailed from New York in August, 1908.

Ground was broken for the observatory, on land set aside by the national government, a month later.

The piers were built of reinforced concrete, and the observatory and dwelling of brick, with wooden roofs covered with rubberoid. The shutters for the meridian circle building were constructed at Albany, before starting, and were taken out by freight along with the rails for the floor, instruments for preliminary adjustment, chronometer and one of the astronomical clocks.

Five months later the dwelling was ready for the staff of ten men, and the observatory was completed for the installation of the Pistor and Martins instrument of the Dudley Observatory.

Observing on the regular list was begun in April, fundamental and miscellaneous observing being taken up. The full list contained 15,000 stars. About 1,600 of these were fundamentals, of varying degrees of precision; from 4 to 32 observations were taken of each; usually the observations have been in excess of the requirements. The first year 61,000 observations were made, though, from the time observations were in full swing, 62,000 were made in one year. About 300 nights were available for observations, of which 200 were clear throughout, in the first year. At the close of the work, in January, 1911, there had been made 87,000.

These were taken in 650 series, of which a full night would include two.

Above 300 fundamental series had been made, each including the observations for groups of primary clock stars twelve hours apart, and those for the combination of successive upper and lower culminations of one or more circumpolar stars.

For the study of the refraction 3,000 observations of stars at large zenith distances were made.

For the corrections to the instrument, collimation had been regularly observed; flexure at the beginning and end of the work; pivot error and division error were measured with sufficient detail to confirm the more elaborate investigations at Albany; and 400 reflection observations were obtained, an average of 40 for each ten degrees employed.

For the personal corrections of the observers, over 2,000 determinations of the magnitude equation were made, by the five telescope observers.

Special determinations of the value of the screen employed accompany this correction. For the bisection error and transit error (N.–S.) 1,750 observations were made. The difference of eye and ear minus chronograph was determined for the observers.

The instrument was dismembered in February of this year, and was returned to the Dudley Observatory, where the reductions will be completed.

Short Formula for Computation of Circum-meridian Azimuths: C. C. SMITH. (Introduced by Dr. W. F. King.)

A short formula for the computation of azimuths observed near the meridian is here given. The ordinary formula for azimuth requires the use of a subtraction logarithm. In the short formula $1 + \cot \delta \tan \phi \cos t$ is expanded in a series and after rearrangement and reduction gives a formula for azimuth which requires the looking up only of the natural logarithm of the declination, after which the multiplications may be quickly carried out on the arithmometer. The formula is much shorter and gives less chance for error than the ordinary formula, especially where a considerable number of observations have been taken at each station.

Changes in Collimation and Level of the Ottawa Meridian Circle: R. M. STEWART.

This paper deals with the observations made at Ottawa from March to December, 1910. Measurements of collimation and level were made usually twice in the course of an evening's work; the changes during the interval (four hours on the average) are here investigated. The average change of collimation was $+0''.03$ for Clamp East and $-0''.20$ for Clamp West; these changes run with great regularity, changing invariably with the reversal of the instrument, and appear to be entirely independent of seasonal and temperature changes or of the interval between the observations. The changes of level were not sensibly affected by reversal of the instrument, but there is some evidence of a small seasonal effect.

Preliminary Measures of the Solar Rotation: J. S. PLASKETT.

This paper is a first contribution towards the scheme of cooperation in determining the solar rotation by the Doppler displacement of the spectral lines, which was organized at the meeting of the Solar Union at Mt. Wilson last September. A large amount of preliminary work which is briefly described has been performed for the purpose of ascertaining the most suitable apparatus and methods for accurate work. The mean of 23 rotation plates, obtained in June and July of the present year, gives, at the equator, a velocity of 2.034 ± 0.004 kms., the probable error of a single plate from the mean of the plates being ± 0.017 km. The average probable error of a single line is ± 0.021 km., varying from ± 0.010 to ± 0.030 km. in the different plates.

The measures of upwards of 50 spectra, in the region allotted to this observatory λ 5,500 to λ 5,700 give no definite indication that the velocity due to any particular lines or elements differs from that of the general reversing layer. Tabulating the residuals from the lines on these plates, it is found that the mean residual, taking account of the signs, is in only one case, and that a faint and diffuse line, equal to as much as one half the average numerical residual. Furthermore, the measures of twelve plates of the spectrum of the sun's limb, which had impressed upon them an arbitrary displacement of the same magnitude and character as the rotation plates, differing from the latter only in the displacement being the same for each line, show small varying displacements of different lines of the same order as those obtained for the rotation plates. It is probable, therefore, that in the region under consideration there is no systematic difference in the velocities of rotation obtained for different lines or elements, the very small differences observed being probably due to the character of the lines for measurement.

Preliminary Report on the Photographs of Halley's Comet taken at Honolulu, H. I., by Ferdinand Ellerman in 1910: E. E. Barnard. (Read by Dr. Slocum.)

The expedition for the observation of Halley's comet, sent in 1910 to the Hawaiian Islands by the Astronomical and Astrophysical Society of America in the sole charge of Mr. Ferdinand Ellerman, established itself on the south slope of Diamond Head about five miles southeast of Honolulu, Oahu Island, and at an elevation of about one hundred and fifty feet above sea-level.

The instrumental equipment consisted of a Warner and Swasey mounting with a six-inch Clark lens, loaned by the Lick Observatory; a metal camera with a Brashear six-inch portrait lens of thirty-two inches focal length, loaned by Brashear; and a wooden camera with a two-and-one-fourth-inch Bausch and Lomb Optical Company-Zeiss Tessar lens of nine and seven eighths inches focus, loaned by the Bausch and Lomb Optical Company. The cameras were carried on the telescope tube.

Mr. Ellerman secured an excellent series of photographs of the comet and made very important though negative observations at the time of the comet's transit across the sun on May 18. On this date, though small spots could be distinctly seen on the sun's surface, no trace of the comet or its nucleus was evident.

Visual observations of the extent of the tail of the comet on the mornings of May 15, 16 and 17 accord with observations made elsewhere. In the record of May 24 occurs the following note: "Nucleus of comet appeared double or dumbbell-shaped. Separation estimated about 20″ of arc."

Mr. Ellerman secured sixty photographs of the comet with the six-inch Brashear camera and thirteen with the Tessar. Many of these photographs are exceedingly interesting, but in the main they agree with other photographs in showing that very little of the abnormal occurred in the phenomena of the comet's tail. One thing apparent in the phenomena of Halley's comet which was first shown in Daniel's comet was the fact that on several occasions two slender streams, which doubtless had their original intersections in the nucleus, receded from the head still connected as if the source of supply were going out with them.

The length and breadth of the tail of Comet Halley as shown on Mr. Ellerman's Tessar plates are here tabulated.

Near its extremity the tail was always very faint on these photographs. On the plate of May 14 at least twelve degrees of the forty-nine recorded was very faint.

Date, 1910	Length of Tail	Width	At Distance from Head
May 4	28°	2°.7	18°
5	31	4.0	19
6	21	2.6	16
7	27	3.1	18
8	24	3.1	18
9	30	3.7	18
11	32	4.3	27
12	43	2.3	27
14	49	4.3	38
28	32	6.6	23
June 1	15	1.8	12

The Solar Prominence of October 10, 1910: Frederick Slocum.

This paper is based upon a series of photographs taken in the light of calcium with the Rumford spectroheliograph of the Yerkes Observatory, and upon some hydrogen photographs, nearly simultaneous, taken by Mr. Ellerman at the Solar Observatory, on Mount Wilson.

The prominence extended from latitude —24° to latitude —40° in the east limb, and reached a height of 105,000 km. In connection with the spectroheliograms are discussed the relations of hydrogen and calcium images, absorption effects due to dark masses projected against bright prominences and gravitational effects upon prominence particles.

Direct photographs of the H and K region of the spectrum between λ 3,910 and λ 3,980, were made with the slit across different parts of the prominence. These show the H_3 and K_3 lines following sinuous courses throughout the whole lengths of the H_2 and K_2 lines. The local relative displacements of the emission and absorption lines amount to $\pm$ 0.20 A, corresponding to velocities of about 15 km. per second if the displacements are manifestations of the Doppler effect.

Vapor-density Effects on the Calcium Lines H, K and g: Oliver J. Lee. (Read by Dr. Slocum.)

The experiment discussed in this paper was undertaken because of the writer's interest in the anomalies shown by these lines of calcium in radial velocity work, and limits itself to determining the relative vapor-densities at which self-reversal occurs.

The high temperature, about 2,500° C., required to vaporize and incandesce calcium makes the usual apparatus for experiments on vapor-density quite useless. The rate of volatilization of the element under standard conditions was assumed to

be constant and was made the basis of the experiment. The apparatus devised consists of a carbon rod, mounted in a spindle and made to rotate between the poles of a right-angled arc fed by a 20-ampere direct current at 40 volts. The end of the rod is bored to receive charges of the metal up to .5 gram. The inside of the bore is projected by a lens upon the slit of a concave grating spectrograph.

The calcium was introduced into series of tubes in two different ways: (1) The tubes were filled with a supersaturated solution of calcium chloride diluted in multiples of two; (2) uniform slivers of metallic calcium each of weight about 2 mgr. were weighed out into charges of from 5 to 100 mgr. and placed in the heating tubes. Each tube was charged only once, and two to five exposures of 20^s each were made with it. About 800 photographs were taken with 225 tubes. The temperature of the bore was determined from a curve constructed with currents and melting points of refractory metals as arguments. The approximate effect of the calcium impurities in the carbon tube and the air was obtained and allowed for.

Conclusion: The lines g, λ 4,227, and H, λ 3,968, require for reversal vapor-densities that are about 1/7 and 3/2 as great, respectively, as that necessary for a reversal of K, λ 3,933, when the vapor is observed at a temperature of 2500° C. and at atmospheric pressure.

(To be published in the *Astrophysical Journal.*)

Radial Velocity of Halley's Comet as Derived from a Spectrogram: Edwin B. Frost. (Read by Dr. Slocum.)

The radial velocity of Halley's comet on May 24, 1910, as determined by the writer from the displacements of the Fraunhofer lines, was + 55 km. per second. The velocity calculated from the ephemeris of the comet agreed with this value within a kilometer.

Note on the Magnitudes of the Stars in the Cluster, Messier 3: S. I. Bailey.

Certain globular clusters appear to be composed of two groups of relatively bright and faint stars, with few stars of intermediate magnitudes. This appearance has been noted by Pickering, Palmer, Fath and the writer.

A recent plate taken by Ritchey on Mount Wilson with the 60-inch reflector, having an exposure of four hours, shows extremely faint stars. An enlargement of this plate, loaned for this purpose by the acting director of the Solar Observatory, was used for the present discussion. The faintest stars shown appear to be of magnitude 21.5. The number of stars is probably not less than 30,000. An enlargement was made with a réseau dividing the photograph into 1,280 squares. The magnitudes of all the stars in 160 of the squares were determined by comparison with the sequence selected for the study of the variables in the cluster. The number of stars thus measured was 2,542. The scale of magnitudes as extended to the fainter stars may be somewhat in error.

Grouped by magnitudes, the number of stars of each magnitude from 13.5 to 21.5 is as follows: 2, 6, 16, 31, 43, 221, 576, 1,071 and 573; the total light derived from the groups in percentages are: 11, 20, 15, 11, 6, 12, 13, 10 and 2. The light of stars fainter than magnitude 21.5, if such exist, is probably negligible. The stars of the four groups, 13.5 to 16.5, give 57 per cent. of the light of all the stars measured, and those of the four groups, 18.5 to 21.5, 37 per cent. The group at 17.5 may be regarded as intermediate, and here the light is a minimum. The total light of the 2,542 stars whose magnitude was determined is approximately equal to that of a star of magnitude 10.4.

From the relation between the known magnitude of the whole cluster regarded as a single object, and that portion studied in the present paper, assuming that the distribution of the stars by magnitudes is the same throughout, the whole number of stars in the cluster may be derived. This number will be in error, if the scale of magnitudes employed is incorrect. By an independent determination of the number of stars by count, the error in the scale of magnitudes, if any, may be determined.

Tables of Effective Wave-lengths of Lines in Stellar Spectra: S. Albrecht. (Read by Mr. W. E. Harper.)

This paper is a report of progress in the work, begun in 1906, of determining the effective wave-lengths of spectrum lines in stellar spectra. The writer has determined tables of wave-lengths for each of the main divisions of the Draper classification (as modified by Miss Cannon) from types B to M, both inclusive. The part of the spectrum covered is from λ 4,236 to λ 4,655. The work is based on measures made, while at the Lick Observatory, on spectrograms taken with (*a*) the Northern Mills three-prism spectrograph having λ 4,500 central with Ti-spark comparisons; (*b*) the Southern Mills three-prism spectrograph, λ 4,450 Central and Ti-spark comparisons; (*c*) the

same Southern Mills spectrograph but with λ 4,340 Central and Fe-spark comparison spectra. These tables are preliminary to the more extensive investigation which has been made possible by the generous loan from observatories in different parts of the earth of suitable sets of spectrograms.

The relative accuracy attained, though naturally not quite equal to that of the International secondary and Kayser's tertiary standards, apparently approximates these in each set of measures separately for a large number of the lines which are best suited for accurate measurement. Differences of a systematic nature were encountered which might easily have escaped notice if the work had been based upon only one instead of three practically different sets of spectrograms.

A large number of lines has been found, in addition to those already published, whose wave-lengths vary progressively from type to type.

Inasmuch as the accuracy attainable in the relative wave-lengths of lines in stellar spectra, with a good modern three-prism spectrograph, is not much inferior to the accuracy of the available standards of wave-length, it is important for the future progress in this work that results show clearly on what line or group of lines any newly determined wave-lengths are based. Designations like "On the Rowland system" are not sufficient. Results should be published in such form as to be readily convertible to any standard system. This should be done with due regard to the increasingly necessary precaution to condense published results as much as possible without impairing their usefulness.

Wave-lengths of the Silicon Lines λ 4,552.7, λ 4,567.9 and λ 4,574.9 in Stellar Spectra and in Laboratory Spectra: S. ALBRECHT. (Read by R. J. McDiarmid.)

Among the lines whose wave-lengths were de-determined as part of the extensive program referred to in my preceding note are the three silicon lines λ 4,552, λ 4,567 and λ 4,574, which were first identified with silicon, in stellar spectra, by Lunt. It is not within the scope of this paper to go into much detail. The principal object, besides giving the wave-lengths in stellar spectra, is to call attention to the need of more extensive study of these lines in the laboratory. This will be evident from the tables given below. In table I. are given the wave-lengths of these lines as determined from stellar spectra. For purposes of comparison with the wave-lengths obtained from the Lick spectrograms, I have computed the wave-lengths from the measures of Frost and Adams, published in the Publications of the Yerkes Observatory, Vol. 11. Table II. gives a summary of the determinations of the wave-lengths in stars and in the laboratory.

TABLE I

Based on	In Stars	Determined from		
		Types	No. of Spectrograms	No. of Stars
Lick spectrograms...	4552.752	B to B2	47	7
	.798	B3 to B5	8	4
Mean...............	*4552.759*	B to B5	55	11
Yerkes spectrograms	4552.770	B to B3	42	10
	.717	B5 to A	5	3
Mean...............	*4552.765*	B to A	47	13
Lick spectrograms...	*4567.970*	B to B5	49	9
Yerkes spectrograms	*4567.963*	B to A	44	12
Lick spectrograms...	*4574.916*	B to B3	41	6
Yerkes spectrograms	*4574.920*	B to A	22	9

TABLE II

Wave-length in Stars			Laboratory Values			
			With High Dispersion		With Low Dispersion	
Albrecht	Gill	Mc-Clean	Exner & Haschek	Frost & Brown	Lock-yer	Lunt
4552.762	4552.79	4552.6	*4552.75*	*4552.64*	4552.8	4552.75
4567.967	4567.90	4567.5	*4567.95*	*4567.90*	4568.0	4567.82
4574.918	4574.68	4574.5	*4574.9*	*4574.79*	4574.9	4574.86

The values of the wave-lengths in stars, table I., as determined from the Lick spectrograms and from the Yerkes spectrograms are in very close agreement. The early determinations by Gill and by McClean, which are added in columns 2 and 3 for the sake of completeness, were, I believe, determined with low dispersion. The laboratory values, table II., by Exner and Haschek (*Aph. Jour.*, 12, 49, 1900) and by Frost and Brown (*Ibid.*, 22, 159, 1905) were both determined with high dispersion. The wave-lengths by Exner and Haschek are slightly smaller, 0.016 Å, on the average, while the values of Frost and Brown are 0.122 Å, 0.067 Å and 0.128 Å smaller, respectively, for the three lines than the wave-lengths in stars. The two laboratory determinations differ by 0.11 Å 0.05 Å and 0.11 Å, respectively, for the three lines, which is equal to an average systematic difference of 0.090 Å. Measures by Frost of another plate, taken by Mr. Fulcher, of the

silicon spark in air gave the wave-length of λ 4,567 ". . . quite a little larger than on the plates taken with the observatory grating." This latter measure was not given, but it is in the direction of the value for the line by Exner and Haschek. Frost (*Aph. Jour.*, 1910) recognized the fact that the use of his laboratory determinations of the wave-lengths did not increase the accordance, in stellar spectra, of the velocities from the separate silicon lines.

The large systematic differences in the laboratory determinations would indicate that the effective wave-lengths of these lines may be influenced, in some way at present unknown, by the conditions of the experiment. As the lines are generally diffuse and are sensitive to the atmosphere surrounding the spark, it seems likely that differences in the electrical conditions of the spark or in the surrounding atmosphere produce an unsymmetrical widening of the lines.

Further laboratory investigation of these lines, under a variety of different conditions, is of great importance in the discussion of fundamental problems in astrophysics.

On Fundamental Systems of Wave-lengths in Stellar Spectra, and especially for the B Type Stars: S. ALBRECHT. (Read by Mr. Parker.)

The object of this note is to point out a clew to the elimination, in part at least, of systematic errors in the wave-lengths of the B type stars.

In the stellar spectral types A to M a considerable number of the spectrum lines in two or more neighboring main divisions of the spectral classification have a common origin. This makes possible a comparison of the wave-lengths in any one type with the wave-lengths or system of wave-lengths in any other type, from types A to M, both inclusive. In consecutive spectral types the systems of wave-lengths can be compared with comparative ease. In the B types, however, the lines are, with a few exceptions, of entirely different origin from the lines of even the A type, and it is only by means of the few lines which the B and A types have in common that the system of wave-lengths in the B type can be connected with the systems of wave-lengths in types A to M.

A connection with each other of the systems of wave-lengths in the different spectral types is highly desirable in the solution of several problems, the more important of which are perhaps: (*a*) the classification of stellar spectral types; (*b*) the elimination from the system of wave-lengths for each type of shifts, other than those due to radial velocity, which are systematic for the entire system of lines, or for groups of lines in each type, and which may be due to such effects as "pressure" or to other causes. The shifts which are shared by all lines are at present included in the radial velocities of the stars.

One of the best lines which is at present available for this purpose is H-gamma. The wave-length in the A type was found to be 4,340.655, and it diminishes progressively, slowly from types A to G and more rapidly from types K to M. If we make a plot with wave-lengths as ordinates and spectral types as abscissæ, a smooth curve can be drawn through the points in the plot from types A to M. If this curve were extended to the B type, it would indicate a wave-length for that type of 4,340.657. The wave-length actually found for the line in the B types is 4,340.627.

As pointed out above this difference for the B type, relatively to other spectral types, is at present to be taken as merely an indication of a method of approach for the solution of this problem. The final solution will have to be based upon a greater number of lines, extending over a longer portion of the spectrum. For a proper distribution to each spectral type, of relative differences which may be found in the different types, it will be absolutely essential to have an accurate knowledge of the behavior of spectrum lines under various different conditions.

In conclusion I wish to refer briefly to the importance which the solution of this question has in connection with our conception of the structure of the sidereal universe. If the results found for H-gamma should be confirmed by a more extensive investigation, such systematic differences in the radial velocities of stars as a function of the spectral type, as were found, I believe, by Kapteyn, Frost and Campbell, may find a simple explanation.

Photographic Determination of the Position of the Moon: HENRY NORRIS RUSSELL. (Read in connection with the Symposium on Photographic Astrometry.)

The photographs discussed below were taken at Harvard by Mr. King, and, by the kindness of Professor Pickering, were sent to the writer for discussion. They were measured and reduced at Princeton by Professor A. H. Joy, of the Syrean Protestant College, Beirut, and the writer, according to plans prepared by the latter. An account of the results will soon appear in the *Harvard Annals.*

To secure comparable images, the exposures to the moon must be less than a thousandth of those on the neighboring stars; and, except during this short exposure the objective must be completely shielded from the moon's rays to avoid fogging by diffusely reflected light. This was accomplished by placing a disk, some distance in front of the telescope, which shades the objective from the moon, but is not so large as to cut off much of the light from the surrounding stars. This disk may be turned edgewise for a short exposure on the moon, the exact time of which is recorded chronographically.

The instrument employed was the Metcalf telescope of sixteen inches aperture and eighty-seven inches focal length, stopped down to 3½ inches aperture, with a disk five inches in diameter carried on a pole nine feet long attached to the telescope tube. Exposures of ten minutes on the stars and of 0.2 to 0.4 second on the moon, gave very satisfactory plates.

A standard réseau was photographed on each plate. The rectangular coordinates of the stars chosen for reference points were measured with respect to this system, and also those of ten or more points on the moon's illuminated limb (most of these being the intersections of the limb and réseau lines). After allowing for the slight distortion of the moon's apparent disk by refraction, the circle which passed as close as possible to the measured points on the limb was determined by least-squares, and its center assumed to coincide with that of the moon. The determination of the right ascension and declination corresponding to this point on the plate and the comparison with the tabular places of the American Ephemeris, were made in the usual way.

The probable error with which the coordinates of a star relative to its neighbors are determined from a single plate is $\pm 0''.25$. The absolute positions of the same stars, given in the catalogues consulted, appear to have probable errors of about $\pm 0''.4$ in each coordinate. The measures of the moon's limb are almost as accurate as those of the star-images; but the actual irregularities of the surface raise the probable error of position of one measured point (determined by means of its departure from the mean circle of the limb) to $\pm 0''.47$.

More dangerous than any of these errors is that arising from imperfect guiding. If the telescope is not directed towards exactly the same point in the heavens during the short exposure on the moon as, on the average, it is during the long exposure on the stars, errors will result which with a poor mounting might be very serious.

To investigate such errors, special plates were taken, on which bright stars were photographed in exactly the same way as the moon. These showed that the combined effects of errors of guiding and measurement is equivalent to a probable error of $\pm 0^s.031$ in R.A. and $\pm 0''.29$ in declination.

Combining all these results it appears that the known errors of observation will account for probable errors in the deduced places of the moon of $\pm 0^s.044$ in R.A. and $\pm 0''.40$ in declination.

Eleven plates have so far been discussed. The agreement of pairs taken on the same night is satisfactory. Comparison of the results of observations on different nights is complicated by the fact that the errors of the moon's tabular place are now large and variable. Through the courtesy of the Astronomer Royal, Professor Dyson, the results of the Greenwich meridian observations of the moon are available for comparison. The Greenwich and Harvard results agree excellently *inter se*, showing that in December, 1910 (during which month most of the plates now discussed were taken), the moon was ahead of her tabular position by an amount varying from $10''.7$ on December 9 to $4''.8$ on December 22, and at the same time $0''.6$, on the average, south of the tabular place. Representing this by an empirical curve, it is found that the outstanding probable errors of one observation at Greenwich are $\pm 0^s.048$ R.A. and $\pm 0''.57$ in declination, while those of the result of one plate are $\pm 0^s.043$ and $\pm 0''.55$.

The photographic method, therefore, appears to give results, on its first trial, somewhat superior in accuracy to those of meridian observations of the first class. It also appears, upon comparison of the observed and predicted probable errors of observation, that the greater part of the error of the photographic results arises from definitely known sources of error. There is little doubt that these can be considerably diminished by appropriate methods.

The photographic method has also the two great advantages that its errors are for the most part different in origin from those of meridian observations, and hence independent of them, and that it is available over a wide range of hour angles. It seems, therefore, likely to prove of great value in the attempt to improve our knowledge of the moon's motion.

Many more plates have already been taken at

Harvard, and it is hoped that arrangements for their regular measurement will soon be completed.

Note on the Ellicott Astronomical Instruments: A. E. DOUGLASS.

These five instruments are now on permanent exhibition in the U. S. National Museum at Washington. They were partly made by Ellicott between 1780 and 1790 and were all used by him between that time and 1820. The zenith sector, six feet in focus, is suspended by its objective end. The eye end carries an arc, divided to degrees, which passes beneath a plumb line. The fractions of degrees are read by a micrometer. This is the type of instrument by which Bradley discovered aberration and nutation and with which the flattening of the earth's figure was first determined. This telescope itself was made by the Rittenhouse brothers in Philadelphia before 1784 and is a copy of the instrument used in locating Mason and Dixon's line. This instrument was used in locating the point where the boundary between the United States and Canada touches the St. Lawrence River. Bradley's original sector with its iron tube and mounting is now in the Royal Observatory, Greenwich. The small zenith sector, 20 inches in length, was used as a substitute for the larger in much boundary work.

The "transit and equal altitude" instrument was used in laying out the boundaries and avenues of the city of Washington, and many state boundaries. It is the type used in much surveying work in the eighteenth century. Instruments of this type may also be seen in the American Philosophical Society at Philadelphia, at Harvard University and in the Museum of the Buffalo Historical Society.

The quadrant is the oldest type of measuring telescope and is likely to be the oldest of this collection. A similar instrument of larger size is at Harvard University. There are many in the European Science Museums.

The four-foot telescope was made by W. and S. Jones, of London. It was used for longitude work by observations of Jupiter's satellites.

The metal work of these instruments is entirely of brass and, except for two of the smaller lenses, all are in excellent condition.

Report of the Committee on Photographic Astrometry: F. SCHLESINGER, chairman.

The report of this committee took the form of a symposium. The chairman outlined briefly what had been done previously on the determination of star places by photography. The experiments of Pickering, Hagen, Hirayama, Trümpler, Donner, Jacoby, Cookson, Ross and Pluvinel were briefly described. The chairman then presented the following resolutions, which were adopted at a meeting of the committee held in New York on April 23, 1911, when there were present Messrs. H. Jacoby, E. C. Pickering, H. N. Russell, F. Schlesinger, E. W. Brown and S. A. Mitchell, the last two by invitation:

RESOLUTIONS

The Committee on Photographic Astrometry of the Astronomical and Astrophysical Society of America is strongly of the opinion that photographic methods can be applied successfully to absolute as well as to differential determinations of star positions, thereby gaining the advantage of independent observations with instruments of entirely different characters. The committee recommends:

1. That the north and south polar points be determined by means of trails secured with a fixed telescope according to the method originally proposed by Pickering and developed by Jacoby.

2. That these polar points be connected with a number of regions on the equator and that the latter be connected among themselves by the methods proposed by Turner on pages 427 et seq., Vol. LXXI., *Monthly Notices of the Royal Astronomical Society.*

3. That the method proposed by Pickering (to be published soon in the *Harvard Circulars*) be used to determine the positions of stars to the twelfth magnitude in the immediate vicinity of the equator.

4. That the differential method proposed by Turner (page 422, Vol. LXXI., *Monthly Notices of the Royal Astronomical Society*) be employed to ascertain the positions of stars referred to the standard regions mentioned under 2.

The committee is further of the opinion that the degree of accuracy attainable by these methods can not be predicted with certainty, but can be found only by accurate trial.

The symposium then continued with the reading of papers (given above in abstract) by E. C. Pickering and H. N. Russell; and various aspects of the general problem were discussed by Messrs. C. L. Doolittle, Littell, Russell, Tucker, E. C. Pickering, Frisby and the chairman.

R. H. CURTISS,

UNIVERSITY OF MICHIGAN

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

FARADAY LECTURE[1]

THE FUNDAMENTAL PROPERTIES OF THE ELEMENTS

WE meet to-night to honor the memory of Michael Faraday. It is fitting that we should come to this historic place; for here were his home and his laboratory, and in this room he lectured. Science is one of the great influences promoting the solidarity of mankind; it is world-embracing, and recognizes no bounds of nationality. Faraday's work especially was a message to the whole world, and has grown into a priceless heritage for all humanity. Therefore, from time to time the generous guardians of this famous lectureship have called chemists and physicists from many lands to honor his unique genius. England, Germany, France, Italy, Russia have all sent eminent representatives; and now from across the sea there comes a pilgrim who is proud indeed to bring the homage of the new world to this shrine of cherished memories. The many ties which bind together our two nations add especial pleasure to the fulfilment of the trust.

The mystery that enshrouds the ultimate nature of the physical universe has always stimulated the curiosity of thinking man. Of old, philosophers sought to solve the cosmic problem by abstract reasoning, but to-day we agree that the only hope of penetrating into the closely guarded secret lies in the precise estimation of that which is tangible and visible. Knowledge of the

[1] Delivered before the fellows of the Chemical Society in the theater of the Royal Institution, on Wednesday, June 14, 1911. Printed in the *Journal of the Chemical Society*, Vol. 99, p. 1201, 1911. See also *Proceedings* of the Chem. Soc. Vol. 27, p. 177, 1911.

actual behavior of material and of energy provides the only safe basis for logical inference as to the real essence of things. Faraday was deeply imbued with this conviction; and it is widely recognized as the basis of all modern experimental science. The subject of my lecture to-night concerns the methods and general results of several extended series of investigations, planned with the hope of adding a little to the foundations of human knowledge by means of careful experiment.

At the outset let me remind you of an old saying of Plato's, for it sounds the keynote of the lecture: "If arithmetic, mensuration and weighing be taken away from any art, that which remains will not be much."[2] In other words, the soundness of all important conclusions of mankind depends on the definiteness of the data on which they are based.

Lord Kelvin said: "Accurate and minute measurement seems to the non-scientific imagination a less lofty and dignified work than looking for something new. But nearly all the grandest discoveries of science have been the rewards of accurate measurement and patient, long-continued labor in the minute sifting of numerical results."[3] The more subtle and complicated the conclusions to be drawn, the more exactly quantitative must be the knowledge of the facts.

Measurement is a means, not an end. Through measurement we obtain data full of precise significance, about which to reason; but indiscriminate measurement will lead nowhere. We must choose wisely the quantities to be measured, or else our time may be wasted.

Among all quantities worthy of exact measurement, the properties of the chemical elements are surely some of the most fundamental, because the elements are the vehicles of all the manifold phenomena within the range of our perception.

Weight is clearly one of the most significant of these properties. The eighty or more individual numbers which we call the atomic weights are perhaps the most striking of the physical records nature has given us concerning the earliest stages of the evolution of the universe. They are mute witnesses of the first beginnings of the cosmos out of the chaos, and their significance is one of the first concerns of the chemical philosopher.

Mankind is not yet in a position to predict any single atomic weight with exactness. Therefore the exact determination of atomic weights rests upon precise laboratory work; and in order to arrive at the real values of these fundamental constants, chemical methods must be improved and revised so as to free them from systematic or accidental errors.

What, now, are the most important precautions to be taken in such work? These are worthy of brief notice, because the value of the results inevitably depends upon them. Obvious although they may be, they are often disregarded.

In the first place, each portion of substance to be weighed must be free from the suspicion of containing unheeded impurities; otherwise its weight will mean little. This is an end not easily attained, for liquids often attack their containing vessels and absorb gases, crystals include and occlude solvents, precipitates carry down polluting impurities, dried substances cling to water, and solids, even at high temperatures, often fail to discharge their imprisoned contaminations.

In the next place, after an analysis has once begun, every trace of each substance

[2] Plato, "Philebus" (trans. Jowett), 1875, Vol. IV., p. 104.

[3] Sir W. Thomson (Lord Kelvin), "Address to British Association," August, 1871, *Life*, II., 600.

to be weighed must be collected and find its way in due course to the scale-pan. The trouble here lies in the difficulty in estimating, or even detecting, minute traces of substances remaining in solution, or minute losses by vaporization at high temperatures.

In brief, "the whole truth and nothing but the truth" is the aim. The chemical side of the question is far more intricate and uncertain than the physical operation of weighing. For this reason it is neither necessary nor advisable to use extraordinarily large amounts of material; from five to twenty grams in each experiment is usually enough. The exclamation, "What wonderfully fine scales you must have to weigh atoms," indicates lack of knowledge; the real difficulties precede the introduction of the substance into the balance case.[4] Every substance must be assumed to be impure, every reaction must be assumed to be incomplete, every measurement must be assumed to contain error, until proof to the contrary can be obtained. Only by means of the utmost care, applied with ever-watchful judgment, may the unexpected snares which always lurk in complicated processes be detected and rendered powerless for evil.

Among all the possibilities of error, the unsuspected presence of water is perhaps the most frequent and most insidious. Hence I shall show you a device for overcoming this potent source of confusion, a device which has played a great rôle in the recent researches concerning atomic weights at Harvard, and is in large measure responsible for such value as the results may possess. The instrument[5] enables one to dry, enclose and weigh an anhydrous substance in such a manner as to preclude the admission of a trace of water from the atmosphere; it might well find applications in every quantitative laboratory. The simple device consists of a quartz ignition tube fitted to a soft-glass tube which has a projection or pocket in one side (Fig. 1). A weighing-bottle is placed at the end of the latter tube, and its stopper in the pocket. The boat containing the substance to be dried is heated in the quartz tube, surrounded by an atmosphere consisting of any desired mixture of

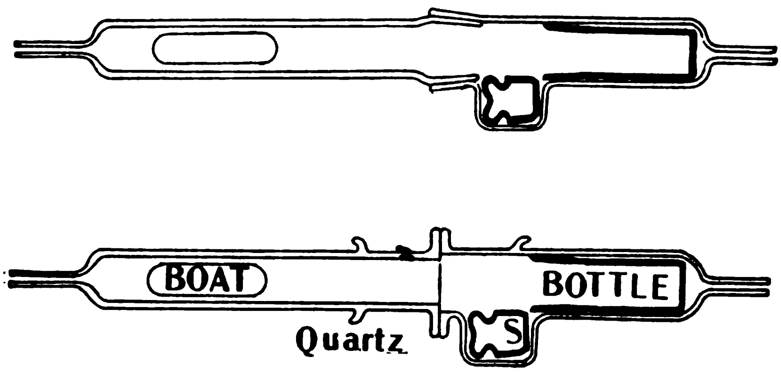

FIG. 1.

[4] Richards, "Methods Used in Precise Chemical Investigation," published by the Carnegie Institution of Washington, 1910, No. 125, p. 97.

[5] Richards, *Zeitsch. anorg. Chem.*, 1895, 8, p. 267; also Richards and Parker, *ibid.*, 1897, 13, p. 86. One form of apparatus shown in this diagram is slightly different from the original arrangement, although the main idea is the same. The flat ground joint between quartz and glass allows for their different coefficients of expansion, and makes a quartz tube interchangeable with any other, in case of breakage.

gases. These gases are displaced, after partial cooling, first by nitrogen, and then by pure dry air, and the boat is pushed past the stopper into the weighing-bottle, the stopper being then forced into place, and the substance thus shut up in an entirely dry atmosphere. The weighing-bottle may now be removed, placed in an ordinary desiccator and weighed at leisure. The substance is really dry, and its weight has definite significance.

Mention may be made also of another instrument, which likewise has greatly facilitated the recent work at Harvard, namely, the "nephelometer."[6] With the nephelometer, minute traces of suspended precipitate may be approximately determined from the brightness of the light they reflect. The construction is very simple. Two test-tubes, near together and slightly inclined toward one another, are arranged so as to be partly shielded from a bright source of light by sliding screens. The tubes are observed from above through two thin prisms, which bring their images together and produce an appearance resembling that in the familiar half-shadow polarimeter. The unknown quantity of dissolved substance is precipitated as a faint opalescence in one tube by means of suitable reagents; and a known amount, treated in exactly the same way, is prepared in the other. Each precipitate reflects the light; the tubes appear faintly luminous. If the tubes show like tints to the eye when the screens are similarly placed, the precipitates may be presumed to be equal in amount. In case of inequality of appearance, the changed positions of the screens necessary to produce equality of tint give a fairly accurate guide as to the relative quantities of precipitate in the two tubes. Traces of substance, which are too attenuated to be caught on any ordinary filter, may thus be estimated.

The two errors obviated by these simple devices—namely, the presence of residual water and the loss of traces of precipitate, respectively—have perhaps ruined more previous investigations than any other two causes, unless the inclusion of foreign substances by precipitates may be ranked as an equal vitiating effect. But these are merely details; the scope and method of the recent work on this subject at Harvard (in the course of which thirty atomic weights have been redetermined) may be seen in their full bearing only in the original papers.[7]

That the atomic weights may be connected by precise mathematical equations seems highly probable; but although many interesting attempts have been made to solve the problem,[8] the exact nature of such relationships has not yet been discovered. No attempt which takes liberties with the more certain of the observed values is worthy of much respect. It seems to me that the discovery of the ultimate generalization is not likely to occur until many atomic weights have been determined with the greatest accuracy. No trouble being too great to attain this end, the Harvard work will be continued indefinitely, and attempts will be made to improve its quality, for the discovery of an exact

[6] Richards, *Zeitsch. anorg. Chem.*, 1895, 8, p. 269; Richards and Wells, *Amer. Chem. J.*, 1904, 31, p. 235; Richards, *ibid.*, 1906, 35, p. 510.

[7] An important part in these researches has been taken by G. P. Baxter, and many able students also have assisted the author in the work. A complete bibliography is given in *Publ. Carnegie Inst. of Washington*, 1910, No. 125, p. 91. Most of the papers are reprinted in full in a volume entitled, "Experimentelle Untersuchungen über Atomgewichte," by the author and his collaborators (Hamburg, 1909). The Carnegie Institution of Washington has generously subsidized the work in recent years.

[8] See especially Rydberg, *Zeitsch. anorg. Chem.*, 1897, 14, p. 66.

mathematical relationship between atomic weights would afford us an immeasurably precious insight into the ultimate nature of things.

But weight is only one of the fundamental properties of an element. Volume is almost, if not quite, as important in its own way, although far more variable and confusing. All gases, indeed, approach closely to a simple relationship of volumes, defined by the law of Gay Lussac and the rule of Avogadro, and well known to you all. In the liquid and solid state, however, great irregularities are manifest, and very little system as regards volume is generally recognized.

About twelve years ago, the study of such small irregularities as exist among gases led me to the suspicion of a possible cause for the greater irregularities in liquids and solids.[9] On applying van der Waals's well-known equation to several gases, in some tentative and unpublished computations, it seemed clear that the quantity b is not really a constant quantity, but is subject to change under the influence of both pressure and temperature. This conclusion has also been reached independently by van der Waals himself.[10] But if the quantity b (supposed to be dependent upon the space actually occupied by the molecules) is changeable, are not the molecules themselves compressible?[11]

The next step in the train of thought is perhaps equally obvious. If changes in the bulk of molecules are to be inferred even from gases, may not the expansion and contraction of solids and liquids afford a much better clue to the relative expansion and contraction of these molecules?

Most physical chemists refer all changes in volume to changes in the extent of the *empty space* between the molecules. But are there, after all, any such empty spaces in solids and liquids? Solids do not behave as if the atoms were far apart within them; porosity is often conspicuous by its absence. Take, for instance, the case of glass; the careful experiments of Landolt on the conservation of weight[12] show that glass is highly impermeable to oxygen, nitrogen and water for long periods. Such porosity as occurs in rigid, compact solids usually permits the passage only of substances which enter into the chemical structure of the solids themselves. Thus, nitrogen can not free itself from imprisonment within hot cupric oxide, although oxygen can escape;[13] again, water can not evaporate into even the driest of atmospheres from accidental incarceration in crystals lacking water of crystallization.[14] Palladium, on occluding hydrogen, is obliged to expand its bulk in order to make room for even this small addition to its substance. The behavior of platinum, nickel and iron is probably analogous, although less marked.[15] Fused quartz, impermeable when cold, allows of the passage of helium and hydrogen at high temperatures;[16] but most other gases seem to be refused admission, and

[9] Richards, "The Significance of Changing Atomic Volume," *Proc. Amer. Acad.*, 1901, 37, p. 1; 1902, 37, p. 300; 1902, 38, p. 293; 1904, 39, p. 581; *Zeitsch. physikal. Chem.*, 1902, 40, pp. 169, 597; 1903, 42, p. 129; 1904, 49, p. 15.

[10] Van der Waals, *Zeitsch. physikal. Chem.*, 1903, 28, p. 257. His earlier publication on this topic (*Proc. R. Akad. Wetensch. Amsterdam*, 1898, 29, p. 138) was unknown to me at that time. See also Lewis, *Proc. Amer. Acad.*, 1899, 35, p. 21.

[11] Van der Waals speaks cautiously, but with some conviction, as to the probable compressibility of the molecules on p. 283 of the paper cited above.

[12] H. Landolt, "Ueber die Erhaltung der Masse bei chem. Umwandlungen," *Abhandlung der königl. preuss. Akad. der Wissenschaften*, 1910.

[13] Richards, *Zeitsch. anorg. Chem.*, 1892, 1, p. 196; *Proc. Amer. Acad.*, 1893, 28, p. 200.

[14] Baker and Adlam, *J. Chem. Soc. Trans.*, 1911, 99, p. 507.

[15] Richards and Behr, *Publ. Carnegie Inst.*, 1906, No. 61.

[16] Jacquerod and Perrot, *Compt. rend.*, 1907, 144, p. 135.

very many solid substances appear to act as effective barriers to the passage of even hydrogen and helium, especially when cold. In these cases, as in so many others, the so-called "sphere of influence" of the atom is the actual boundary by which we know the atom and measure its behavior.[17] Why not call this the actual bulk of the atom?

From another point of view, the ordinary conception of a solid has always seemed to me little short of an absurdity. A gas may very properly be imagined with moving particles far apart, but what could give the rigidity of steel to such an unstable structure? The most reasonable conclusion, from all the evidence taken together, seems to be that the interstices between atoms in solids and liquids must usually be small even in proportion to the size of the atoms themselves, if, indeed, there are any interstices at all.

Very direct and convincing evidence of another sort is at hand. The idea that atoms may be compressible receives striking confirmation from a recent interesting investigation of Grüneisen[18] concerning the small effect of low temperatures on the compressibility of metals. The average compressibility of aluminium, iron, copper, silver and platinum falls off only seven per cent. between the temperature of the room and that of liquid air. Extrapolation of the curves indicates that at the absolute zero very little further diminution should occur. As far as we can guess, therefore, the hard metals are almost as compressible at the absolute zero as at room temperatures. But at the absolute zero all heat-vibration is supposed to stop; hence this remaining compressibility must needs be ascribed to the atoms themselves.

If the atoms are compressible, all mathematical reasoning which assumes them to be incompressible rests upon a false basis. The kinetic theory of *gases* remains unmolested by these considerations, except as they indicate the changeability of b in the equation of van der Waals, but the new views affect seriously the application of this equation to solids and liquids.

Let us proceed to trace a few of the outcomes of our hypothesis. If atoms may really be packed closely together, the volumes of solids and liquids should afford valuable knowledge concerning the relative spaces occupied by the atoms themselves under varying conditions. The densities of solids and liquids then assume a significance far more interesting to the chemical philosopher than before, because they have a more definite connection with the fundamental nature of things.

An apparent objection at once suggests itself; if the particles in condensed material are really touching one another, how can we account for heat within the material? Would such closely packed atoms be able to vibrate?

The theory of compressible atoms supplies as one of its own corollaries the immediate answer to this question. If atoms are compressible throughout their whole substance, they may contract and expand, or vibrate within themselves, even when their surfaces are prevented from moving by being closely packed together. It is thus possible to conceive of a vibrational effect, even in contiguous atoms, provided we can conceive of these atoms as being elastic

[17] Since these ideas were first advanced, Barlow and Pope have brought forward much interesting evidence concerning the significance of the volumes of solids and liquids, which supports the idea that the atoms are closely in contact with one another (*Trans.*, 1906, 89, p. 1675; 1907, 91, p. 1150; 1908, 93, p. 1528; 1910, 97, p. 2308).

[18] E. Grüneisen, *Ann. Physik*, 1910 (IV.), 33, p. 1239. The *relative* values for the compressibilities recorded in this investigation are doubtless trustworthy, although the absolute magnitudes are somewhat uncertain because they depend on the rather inadequate theory of elasticity.

throughout all their substance. Agitation sufficient to produce even the Brownian movement might easily exist in such a system.

Clearly there is nothing impossible or obviously contradictory to experimental knowledge in the notion that atoms are compressible; indeed, the old idea of small, hard particles far apart is really more arbitrary and hypothetical than the new conception. The obvious simplicity of the latter is rather in its favor than otherwise, as in Dalton's atomic theory. In general, the more simply an hypothesis interprets the phenomena of nature, the more useful the hypothesis is likely to be, provided, of course, that the interpretation is adequate. The modern philosophy of pragmatism is a

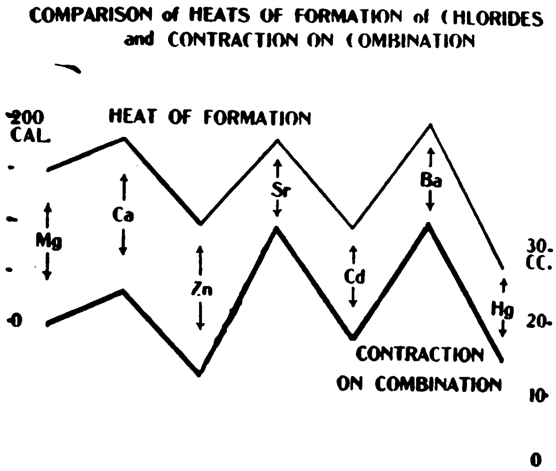

Fig. 2.

good guide in such matters; a theory not obviously illogical should be judged by its usefulness. Let us then test the new hypothesis by applying it to other aspects of physical chemistry.

If pressure produces a change in the sizes of the atoms and molecules themselves, may not the actual volumes of liquids and solids be used as a guide to the unknown internal pressures within them? Cannot we thus discover whether or not chemical affinity exerts pressure in its action? To follow this clue, the simplest possible case was chosen at first, namely, the comparison of the contractions taking place on combining several elements in succession with a single very compressible one. The changes of volume occurring during the formation of oxides were first computed; later, chlorides and bromides were studied. According to the theory of compressible atoms, we should expect to find greater contraction in cases of greater affinity. The diagram (Fig. 2), which depicts typical data concerning certain nearly related chlorides, strongly supports this inference.[19] One of these lines shows the total change of volume which occurs when a gram-molecule of chlorine combines with the equivalent weight of metal; the other gives the heat evolved during combination. The lines show distinct parallelism; that is to say, reactions evolving much heat manifest great contraction. In cases of this kind the heat of reaction is usually not very different from the change of free-energy, therefore we may infer that greater *affinity* is associated with greater contraction; and it is but a small leap in the dark to guess that the change of volume is *caused* by the pressure of affinity. Since chemical attraction holds two elements firmly together, why should it not exert pressure? And if it exerts pressure, why should not the volume of the system be diminished by this pressure?

This interpretation is not wholly new. Faraday's great teacher, Davy,[20] pointed out for the first time a similar fact; namely,

[19] Richards, *Proc. Amer. Acad.*, 1902, 37, p. 399; also especially *J. Amer. Chem. Soc.*, 1909, 31, p. 188.

[20] Humphry Davy, "Collected Works," 1840, 5, p. 133 (foot-note).

that the contraction which takes place on forming the oxide of potassium is greater than the contraction which takes place on forming several other oxides, and he ascribed this effect to the well-known differences of affinity in these cases; but he did not carry the idea further. Long afterwards, Braun,[21] Mueller-Erzbach,[22] Hagemann[23] and Traube[24] independently and apparently without knowledge of each other's work, called attention to other cases of similar relationships.

All of these researches have produced so little effect on the literature of the subject[25] that they were entirely overlooked during the earlier part of the present investigation. The oversight mattered little, however, because the whole subject needed a fresh attack. Essential factors in the situation had not been noticed by any of these earlier investigators. Affinities, indeed, had been considered, but the nature of the substances on which the affinities act had been overlooked. Evidently the change of volume in any case must depend not only on the intensity of the pressure exerted by the affinity, but also, among other things, on the compressibility of the substances concerned. The greater the compressibility, the greater should be the change of volume caused by a given pressure of affinity. Before any definite conclusion can be drawn, the differences in compressibility must be taken into account.

These thoughts led to the measuring of the compressibilities of a large number of elements and simple compounds. The previously employed methods for solids and liquids being unsatisfactory, a new and highly satisfactory method was devised for the work done at Harvard. Pure mercury is compressed in a suitable tube, measuring both pressure and change of volume, and then most of the mercury is displaced by the substance to be studied, again noting the relationship of pressure to volume. The difference between the compressibility of mercury and that of the substance is then easily calculated. Obviously, in such a method as this, the compressibility of the apparatus itself is eliminated. The relation of volume to pressure is easily determined by causing the mercury meniscus to make electrical contact with a very fine platinum point in a tube of narrow diameter, adding weighed globules of mercury, and noting the corresponding pressures.[26] Time forbids the description of the details of the procedure.

The compressibilities of thirty-five elements and many simple compounds were studied by this method with sufficient care to leave no doubt as to their relative values. It became at once manifest that the formation of a compound of a compressible element was attended with greater decrease of volume than the formation of a similar compound of a less compressible element, other things being equal.[27] This is just what the theory leads us to expect, and is a fact inexplicable by any other hypothesis as yet known to me.

Another essential aspect of the theory of compressible atoms is that which concerns

[21] V. Braun, see Johnson, *J. Chem. Soc. Trans.*, 1877, 31, p. 252.

[22] Mueller-Erzbach, *Ber.*, 1881, 14, pp. 217, 2043.

[23] Hagemann (private publication, Friedländer, Berlin, 1900).

[24] Traube, "Ueber den Raum der Atome," Ahrens's *Sammlung der chem. und chem.-techn. Vorträge*, IV., p. 256.

[25] See, for example, Ostwald's *Grundriss der allgemeinen Chemie*, 1899, p. 185.

[26] Richards, in collaboration with Stull, Bonnet, Brink, Mathews, Jones, Speyers, *Publ. Carnegie Inst. of Washington*, Nos. 7 and 76; *J. Amer. Chem. Soc.*, 1904, 26, p. 399; 1909, 31, p. 154; *Zeitsch. physikal. Chem.*, 1904, 49, p. 1; 1907, 61, p. 77.

[27] Richards, *Proc. Amer. Acad.*, 1904, 39, p. 581.

cohesion.[28] If the pressure of chemical affinity causes atomic compression, may not the pressure of cohesive affinity also have the same effect? Traube suggested this possibility, but looked at the whole question from a different point of view.[29] The affinity which prevents solids and liquids from vaporizing is generally admitted to produce great internal pressure; must it not tend to compress the molecules into smaller space? Molecules with high cohesive affinity (those of substances hard to volatilize) should be much compressed and possess small volume, whereas molecules with a slight cohesive affinity should be more bulky. Moreover, those molecules already much compressed by their own self-affinity would naturally be but little affected by additional pressure. Thus, as regards two substances otherwise similar, the less volatile one would be less compressible, denser and possess greater surface tension.[30] These outcomes of the theory agree with the facts in eighty per cent. of the cases thus far studied; for example, *o*-xylene is denser, less volatile, less compressible and possesses a greater surface tension than either *m*-xylene or *p*-xylene.[31] Differences of structure and differences of chemical nature sometimes conceal these relations; the parallelism appears most strikingly among isomeric compounds. In brief, the bulk of evidence strongly indicates that cohesiveness as well as chemical affinity exerts pressure in its action, and hence that each plays a part in determining the volumes occupied by molecules.

Thus the computation of the space occupied by either a solid or a liquid becomes a very complex matter. Not only must the various chemical affinities at work be taken into account, but also the cohesive attraction of both factors and products, and the compressibilities over a very wide range of all the substances concerned. Discoverable parallelism in volume changes is to be expected only when one alone of these forces is the chief variable.

The exact mathematical working out of the consequences is very far in the distance, if, indeed, it can ever be attained. This fact does not, however, militate in the least against the plausibility of the idea. Although mankind has not yet been able to devise a method of mathematical analysis which will solve at one stroke the gravitational relations of three bodies, nature is not on that account prevented from causing three or more bodies to act on one another with the force of gravity, or astronomers from calculating as nearly as may be the consequences by a process of approximation.

Carried through to its logical conclusion, the idea that atoms are compressible gives one quite a new conception of the molecular

[28] *Ibid.*

[29] See especially Traube, *Ann. Physik.*, 1897, (III.), 61, p. 383; 1901, (IV.), 5, p. 548; 1902, 8, p. 267; 1907, 22, p. 519; *Zeitsch. physikal. Chem.*, 1910, 68, p. 289; also Walden, *Zeitsch. physikal. Chem.*, 1909, 66, p. 385. Their interpretation depends largely on the application of van der Waals's equation and the complicating assumption of a *co-volume;* however, Walden's very recent paper presents a number of interesting and important relations concerning internal pressure, which seem to demand the assumption of atomic compressibility for their explanation.

[30] Richards and Mathews, *Zeitsch. physikal. Chem.*, 1908, 61, p. 449.

[31] With the help of C. L. Speyers I have determined these constants with great care. The substances were unusually pure, the *p*-xylene freezing at 13.2°. The details will be published as soon as possible. The results are recorded in the following table:

	Boiling Point	Density, 20°/4°	Surface Tension mg./mm.;20°	Compressibility 10^6 at 20°
o-Xylene .	144.0°	0.8811	3.09	60.0
m-Xylene .	139.0	0.8658	2.96	63.5
p-Xylene .	136.2	0.8611	2.92	66.2

mechanics of the universe. The influence of atomic compressibilities may be perceived everywhere, and in most cases each fact seems to fit easily and without constraint into its place in the hypothesis. Even apparent exceptions, such as the abnormal bulk of ice, may be ascribed in a reasonable fashion to superposed effects. A detailed discussion of many applications of the theory is impossible here, but a few may be suggested, in order to make clearer its possibilities.

The satisfying of each valence of an atom would cause a depression on the atomic surface, owing to the pressure exerted by the affinity in that spot. The stronger the affinity, the greater should be this distortion. Evidently this conception gives a new picture of the asymmetric carbon atom, which, combined with four other different atoms, would have upon its surface depressions of four unequal magnitudes, and be twisted into an unsymmetrical tetrahedron. The combining atoms would be held on the *faces* of the tetrahedron thus formed, instead of impossibly perching upon the several peaks. According to this hypothesis, the carbon atom need not be imagined as a tetrahedron in the first place; it would assume the tetrahedral shape when combined with the other four atoms. One can easily imagine that the development of each new valence would change the affinities previously exercised, somewhat as a second depression in the side of a rubber ball will modify a forcibly caused dimple in some other part. Thus a part of the effect which each new atom has on the affinities of the other atoms already present may be explained.

Many other physico-chemical phenomena assume a new aspect when viewed from the standpoint of this idea. New notions of the mechanism of the critical phenomena, surface tension, ductility, malleability, tenacity and coefficient of expansion are gained. The peculiar relations of material and light, such as magnetic rotation, fluorescence, partial absorption, and so forth, may be referred to the modified vibrations of distorted atoms. The deviations from the exact fulfilment of many older generalizations concerning volume (such as the equation of van der Waals already cited, the comparative volumes of aqueous solutions, especially of electrolytically dissociated substances,[32] and the variations in the crystal forms of isomorphous substances) are seen to be a foregone conclusion. Moreover, the theory, although not necessarily dependent on the modern belief that atoms are built up of numbers of much smaller corpuscles, is consistent with that belief, for would not such an entity be compressible?

The more closely the actual data are studied, the more plausible the hypothesis of compressible atoms appears. Ten years' experience with its interpretations leads me to feel that the idea is highly suggestive and helpful in stimulating new search after truth and in correlating and codifying diverse facts. By such fruit are hypotheses justified.

The relation between heat of reaction and change of volume stimulates interest in chemical thermodynamics and curiosity as to the mechanism of the output of energy during chemical change. A search for accurate data wherewith to reason about this question soon revealed the uncertain nature of many of the figures. Here, in the domain of thermochemistry, as in those of atomic weights and compressibilities, new methods were needed in order to attain precise results. Accord-

[32] Baxter has very recently discussed this matter from the point of view of the theory of compressible atoms (*J. Amer. Chem. Soc.*, 1911, 33, p. 922).

ingly, a device was adopted which at one stroke annihilates the pernicious "cooling correction"—the worst foe to accuracy—by merely causing the temperature of the jacket around the calorimeter to change in temperature at the same rate as the calorimeter itself. There are several ways in which this may be accomplished; among these ways the following was chosen as the best method for a chemical laboratory. The calorimeter, enclosed in a slightly larger water-tight vessel, with tubes above —a kind of submarine—is immersed under the surface of dilute crude alkali in a pail. Thermometers inside and out enable one to adjust the temperatures at the same point. The reaction is then started in the calorimeter, and at the same moment and at a corresponding rate acid is dropped into the dilute alkali in the pail, so that the two temperatures inside and out keep pace with one another. Thus there is no loss of heat from the inside vessel; the thermochemical reaction is strictly adiabatic. This method has already been used at Harvard with very encouraging outcome in determining a wide variety of thermochemical data, heats of combustion of hydrocarbons, of solutions of metals in acids and of neutralization, specific heats of solutions, and also of the elements at very low temperatures, and finally latent heats of evaporation.[33] It has proved itself especially valuable in the study of slow reactions, where the cooling correction may become a large portion of the total result. The effort is being made to apply to this experimentation concerning chemical energetics the same degree of care which has recently been attempted in the revision of the atomic weights, and although on account of the greater complexity of the problem the percentage accuracy thus far reached has not equalled that in the case of atomic weights, one can not help thinking that the proportional gain over previous investigations is perhaps as great in this case as in the other.

In thermochemical reasoning particularly, accurate data possess a significance wholly denied to cruder results. The relations between the heat of formation of organic substances, if determined accurately enough, may be hoped to throw light on organic structure and the nature of valence. Approximate values are of no use at all for such a purpose. Enough has been done already to suggest relations of a highly interesting sort between heats of combustion, heats of evaporation, compressibility and many other properties; and to add support to the theory of compressible atoms.[34] Moreover, taken in connection with more precise knowledge of the free energy of chemical changes, the new results will permit the evaluation of bound energy, and give results which may decide whether or not bound energy is really a simple function of change of heat capacity, as has been more than once intimated.[35] There is time now only to suggest possibilities, each of which would take hours to elucidate.

How can we collate all the varying properties so as to show their many-sided relationships? How can we piece together the scattered evidence so as to synthesize an adequate conception of the ultimate nature

[33] Richards, in collaboration with Henderson, Forbes, Frevert, Mathews, Rowe, Jesse, Burgess and Jackson, *Proc. Amer. Acad.*, 1905, 41, p. 3; 1907, 42, p. 573; 1908, 43, p. 475; 1911, 46, p. 363; *J. Amer. Chem. Soc.*, 1909, 31, p. 1275; 1910, 32, pp. 268, 432, 1176; *Zeitsch. physikal. Chem.*, 1905, 52, p. 551; 1907, 59, p. 531; 1909, 70, p. 414.

[34] Richards, *Proc. Amer. Acad.*, 1908, 39, p. 581; also *Zeitsch. physikal. Chem.*, 1904, 49, p. 15.

[35] Helmholtz, Lewis, van't Hoff, Nernst and Haber, as well as the author and many others, have contributed to this discussion. An interesting résumé, with references to many of the original papers, will be found in Haber's "Thermodynamics of Technical Gas Reactions" (translated by Lamb), London and New York, 1908.

of things? These questions may never be adequately answered, but science must ceaselessly endeavor to solve the problem which they present.

A first step is clearly to find the way in which each property varies in relation to every other. With this in mind, let us appeal to the irregular system of the periodic classification, which formed the subject of the Faraday lecture by Mendeléeff The device is not new. Carnelley compared Lothar Meyer's atomic volume curve with that of melting points, and other similar data have been plotted; but the method has not been used to its full extent.

Let us then turn to the diagram (Fig. 3) in which the variations in a number of properties are plotted with relation to the atomic weights. Prominent among the lines is the atomic-volume curve just mentioned.

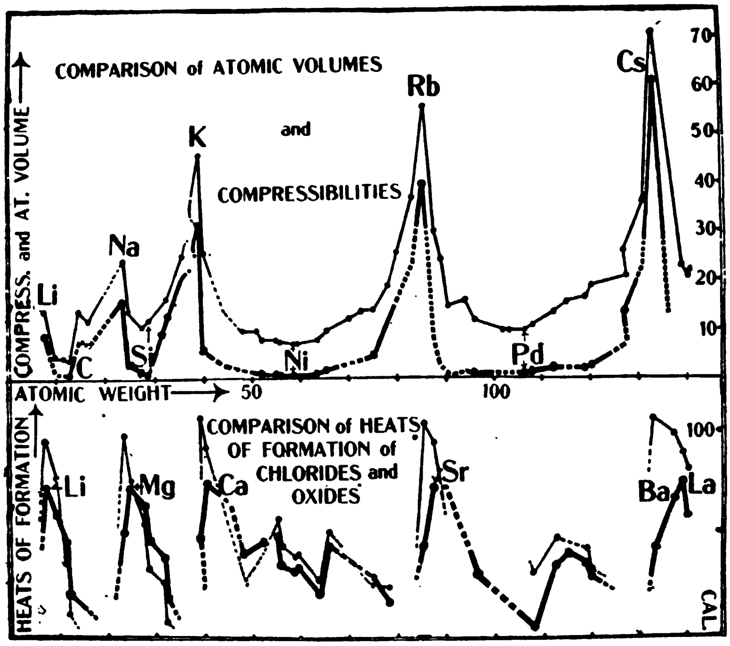

Fig. 3.

Below it is plotted the almost parallel line depicting the compressibilities of the solid elements as determined at Harvard; these are immediately seen to be, like the atomic volumes, periodic functions of the atomic weights. The parallelism can not but suggest that atomic volume and compressibility are fundamentally connected; and, indeed, the theory of compressible atoms gives a plausible explanation of the connection. We should expect the large atomic volumes to be more com-

twenty-two years ago. This mysterious index of uncharted tendencies must hide within itself guiding ideas capable of pointing us onward.

Clearly each property must receive, not merely qualitative, but strictly quantitative treatment. With this in mind, let us compare our various facts by plotting atomic weight in one direction, and all the other properties in another. Then by noting the parallelism or anti-parallelism of the wavy lines, many relationships may be traced.

pressible, because we might infer from their bulk that they are not under as great pressures as the small volumes, and material under slight pressure is likely to be easily compressible. Moreover, the bulky and easily compressible elements are in most cases more easily melted and volatilized than those possessing small volume and slight compressibility. This is just what we might expect; all these properties combine to indicate that the bulky elements have less cohesion than the compact ones.

Next, another set of waves may be considered, representing properties not often depicted in this way. These are the heats of formation of sundry similar compounds, also plotted with relation to the atomic weights. In the third curve are given the heats of combination of chlorine with other elements, and below it a heavy line depicting the heats of the combination of oxygen with these elements, both sets of quantities being expressed in terms of gram-equivalents.

These two run partly parallel with one another; but a deviation in the parallelism appears, which is full of suggestiveness. The peaks of the curves representing oxides shift distinctly to the right of the curve representing chlorides as the atomic weight increases. Lithium marks a maximum with both curves, but the oxygen curve lags greatly at the succeeding peaks, having its maximum with lanthanum at the atomic weight 139,[26] and shifting over as far as lead above 200. This simple fact standing alone would perhaps mean but little, but other similar facts seem to point in the same direction. For example, the property of electro-positiveness, exhibited by the alkali metals, instead of reappearing in copper, has been carried over with diminished intensity to zinc; and finally, among the higher atomic weights the cusp has deserted mercury (the analogue of zinc) and gone as far afield as thallium. Clearly the rate of progression which determines electro-positiveness has a longer "wave-length" than that which determines valence, if we may describe the periodicity of these zigzag curves as waves. Again, the tendency towards low melting point unquestionably likewise progresses with a longer "wave-length" than most of the other properties. In the first complete period, nitrogen, oxygen, fluorine and neon all have very low melting points. At each recurrence of these groups with higher atomic weights the melting point rises, whereas with each recurrence of the immediately following alkali metals the melting point falls. By the time antimony is reached, this analogue of nitrogen has a melting point as high as 900° absolute, whereas the next alkali metal has the lowest melting point of all these metals. Clearly the property of melting has shifted toward the right. Other examples of a similar kind have been pointed out by others,

[26] The essential data for discovering this generalization, namely, the heats of oxidation of the metals having great affinity for oxygen, are as follows: lithium, 72; sodium, 50; magnesium, 72; potassium, 43; calcium, 76; rubidium, 42; strontium, 71; cæsium, 41; barium, 67, and lanthanum, 74. These values correspond with gram-equivalents, that is, combination with eight grams of oxygen, and are expressed in kilogram-calories. The typical oxide is always meant. The figures rest chiefly upon the recent work of Bengade, de Forcrand and Guntz. References to most of the papers are to be found in Abegg's "Handbuch der anorganischen Chemie." The work of Guntz is published in *Compt. rend.*, 1903, 136, p. 1071; 1905, 140, p. 863; *Bull. Soc. chim.*, 1906, (III.), 35, p. 503. The work on lanthanum was done by Matignon, *Ann. Chim. Phys.*, 1906, (VIII.), 8, p. 426. The heat of oxidation of beryllium is not accurately known, but since the oxide may be decomposed by magnesium at high temperatures, the value is very probably less than 70 calories per gram-equivalent.

for example, the well-known displacement from strict periodicity of argon, cobalt and tellurium all point to an unequal rate of progression in isolated cases. Thus, this phenomenon seems to be a general one; the various properties of material seem to oscillate with varying rhythms as the atomic weights increase. The variation is so great that one may almost suspect not only varying rhythms but also rhythms represented by different types of mathematical functions.

These facts suggest a possible reason for the great irregularity of the last part of the periodic table. May it not be that the nature of the elements is determined by several fundamental tendencies which may be compared to the Mendelian characters of the modern theory of heredity? If these characters recur at different intervals as the atomic weight increases, a given rhythm occurring at first would necessarily be obliterated toward the end of the system. To change the analogy and borrow a term from the nomenclature of light, we may say that the tendencies which produce the curves in this diagram, might first reinforce and afterwards interfere with one another, because they possess different wave-lengths. At first, overlapping might accentuate one set of properties; later the changing relation might annihilate this set of properties and cause another. Thus, all the varieties of material may be functions of some few fundamental characteristics which progress at different rates as the atomic weights increase.

Any attempt to discover the nature of these fundamental tendencies must be of a highly speculative character. In our ignorance we can not distinguish between cause and effect. The well-known definite relations of the spectrum lines suggest that at least one of the essential requirements for the existence of an atom may be susceptibility to certain definite harmonic vibrations; those compressible atoms capable of vibrating in certain rhythms may be permanent, whilst other aggregations may be unstable. The gap in the periodic system where *eka*iodine *eka*cæsium should be, and the amazing instability of the elements immediately following, supports the notion.

But here we have a cosmic puzzle for future solution. To-day we lack adequate data, we are blocked at every turn by our ignorance; therefore, the immediate problem is to discover and test each step as carefully as possible. When the facts have been ascertained, man will have a solid basis upon which to build his future superstructure of theoretical interpretation.

The quest is not dictated by mere curiosity alone. All organic life is actuated by chemical energy, and exists in a mechanism and environment composed of chemical substances; and the effort to understand these essential conditions of human existence constitutes one of the most important objects of human endeavor. Superficial observation of the complex phenomena of life can do but little; as Faraday well knew, patient study of the fundamental laws of the physical universe alone can help to unravel the interwoven threads. Health, well-being and a profound philosophic outlook are alike dependent upon the result. No one can predict how far we shall be enabled by means of our limited intelligence to penetrate into the mysteries of a universe immeasurably vast and wonderful; nevertheless, each step in advance is certain to bring new blessing to humanity and new inspiration to greater endeavor.

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SCIENCE AND LITERATURE

SPEECH was given to man to conceal his thoughts, according to some eighteenth-cen-

tury French cynic; and the way in which language is most frequently employed now makes it seem applicable to twentieth-century America. A man is a pessimist who disbelieves in the accuracy of the glowing pictures painted by popular vanity or personal interest, no matter how much faith he may have in more reasonably attested good; and he is an optimist if, either without effort or by the ostrich's expedient of burying its head in the sand, he shows himself absolutely oblivious to the possibility of anything unflattering or uncomfortable ever arising. With equal disregard of their proper application and limitation, the words *science* and *literature* are confused; so that, if anything definite at all is meant by them, it is often something nearer the import of the other, than that of the one employed. It is, of course, not desirable to add to this confusion by attempting to define the words, which are both too extensive in significance for exact definition, but it may not be inappropriate to discuss their meanings to see if any reasons can be discovered to account for their confusion, and for the fact that, mistakenly, they are often used as if they were mutually exclusive, and understanding of or sympathy with the one implied ignorance of or hostility towards the other.

Ultimately, of course, literature and science have the same object—to throw light on the deeper problems of existence; but literature seeks to do this by means of thought, and science by means of knowledge, that is, literature is the product of reflecting on knowledge in its entirety, science devotes itself to systematic observation of its details. The producer of literature, however, must know and observe, just as the scientist must reflect, if he is to be creative; so that each must understand the methods and appreciate the achievements of the other, and inability to do so calls into question a man's right to be considered an author or a scientist, however much pretension he may make to either title. This is the fact of the matter, but contemporary standards are always mediocre, and the popular conceptions of literature and science alike are based on such inferior exhibitions of both that it is not strange that literature should be associated primarily with subjective conjecture, and science with the perceptions of sense rather than of the intellect, and that literature should be looked on as wholly ephemeral and science as wholly material, as they are.

It is not entirely because of mediocre standards, however, that such notions of the nature of science and literature obtain, but because of the character of modern civilization, and also because of the quality of the ideas that dominate the modern mind. The law of the universe, according to the observation of innumerable philosophers, is flux and flow. The earth moves from perihelion to aphelion, the moon from apogee to perigee, and everything else surveyed by the human mind, as well as the human mind itself, moves with a systole and diastole that, though often obscured by the infinite variety of the movements with which it is complicated, is neverthless evident to the observant intellect. In the case of the human mind one exhibition of this movement is between an extreme of dependence on the world of sense without it and another of submission to truths disclosed by inward experiences. If a chart or graph of such movements were drawn, provided, of course, that any one dealing in charts and graphs were capable of comprehending the existence of forces as real and extensive as these, it would be shown that, whatever intervening fluctuations there may be, there are periods when the ideas of men rest almost wholly on the principles of their own nature and others in which external forces rule to an equal extent. In the early centuries of the Christian era, when the civilization of to-day was formed, the dominant thought of the world was guided to a remarkable degree by the observation of human nature, and the external world was correspondingly neglected. With an indifference to anything but the necessity of harmonizing all phenomena with preconceived notions equal to that of the German pedant who evolved a description of the elephant solely from his inner consciousness, the entire material world of early Christian times was assumed, in defiance of much obvious evidence to the con-

trary, to be nothing but a vast pantomime illustrating the spiritual world as religious dogma created it. It was not ignorance of the natural world alone that filled the early *bestiaries* with statements that the ass brayed seven times a day to illustrate the seven deadly sins, or did something else three times to illustrate the trinity, and others of a like nature; such statements were disproved by the daily experience of almost everybody, and their wide circulation and general acceptance can only be explained by the fact that the popular intellect was so engrossed with the contemplation of emotional phenomena as to be unconscious of nearly everything else.

To-day the pendulum has swung to the other extreme, and the human mind conceives everything, not in terms of spiritual experience, but according to the analogy of material phenomena; in fact, it is not too much to say that the modern intellect is as devoid of any intelligent insight into human nature as the early Christian mind was of knowledge of natural history. This of course tends to prevent any profound understanding of literature, for literature is concerned primarily with human nature and only secondarily with nature in its ordinary significance. "Mankind," says Goethe, "is ever changing; man remains ever the same"; and it is the business of literature to exhibit this eternal nature of man through the incessant variations of its external environment. In modern times, however, the progress of civilization has vastly increased the physical forces under man's control, and so obscured those fundamental moral powers with the exercise of which literature is concerned, while it has rendered his artificial environment more complex and more varied, so that its reproduction has become a more interesting and a more important task, and has come to be regarded as the chief concern of literature, although in reality it is only one of its less important functions.

The materialistic intellectual preconceptions of modern times and the artificial character of modern civilization have also affected the teaching and interpretation of literature in a way calculated to give an erroneous impression of its real nature. The pedantry of to-day shows a slavish worship of the literal fact, and, at the same time, an artificiality that is surprising. The human interest is more completely eliminated from literature—whose interest, we have seen, is supremely human—than it ever has been before. A mass of miscellaneous information relating to literary history rather than to literature,[1] mingled with much unsubstantial theorizing and some fragmentary reading is what the colleges present to the student as literary instruction. The classics are no longer taught as the thought of other civilizations; they have become almost exclusively the memorizing of details of accidence and syntax, supplemented at more advanced stages by equally bald and inert information about literary forms or historical relationships. Under these circumstances it is not to be wondered at that the average youth, and every youth who has an acute mind or the courage of his convictions, finds no attraction in the study of the classics. The facts such a study will reveal to him may be complicated and difficult to learn, but so are facts in connection with chemical changes or physical laws; and these latter have, besides their greater direct vocational value, the added advantage of being current and significant to-day and possessed of a greater degree of certitude and demonstrability.

Such is the appeal of literature to the undergraduate, the graduate is no better off. Philology is a significant and interesting study that bears an important relation to the understanding of language, which is the vehicle of literature; but philology is not literature, even though it be a much more secure field for those whose minds are baffled by the illusive nature of that subject. Philology, however, even when it sets itself to tabulating the number of times a certain conjunction or adverb occurs in some author or text, has far more to justify it than the other form of literary scholarship that is most industrious to-day. By this latter the student is encouraged to expend his energies on questions as indeterminate and fu-

[1] See Babbitt, "Literature and the American College."

tile as the most ridiculous ones of the medieval schoolmen. In the field of English scholarship, for instance, a great deal of effort has been put forth to determine the exact route of the Canterbury Pilgrimage, and where the knight began and ended his tale, where the Chanoun's yemanne joined the cavalcade, and similar points, as if it were an actual historical occurrence. Such an attempt as this is just as ridiculous as it would be to try to determine whether it was the right or the left slipper that Cinderella lost, if the story leaves us in doubt on that point; for the Canterbury Pilgrimage, although it may well have had one or several prototypes, never took place in anything like the form we know it anywhere else than in Geoffrey Chaucer's brain. This is the sort of task that lies within the compass of uninspired industry, but it has nothing else to recommend it; and when students are encouraged to devote themselves to such tasks, under the name of constructive scholarship, and questions so artificial and so remote from significant facts and fixed principles are thus associated so extensively with literature, it is no wonder that it suffers in public esteem, and that it has come to be considered by many as profitless speculation.

Something, though, that is worse for literature than its association with philology and pedantry is its confusion with dilettantism. There are no rewards offered to-day for the production of literature of a high order, there has been no intellectual or moral stimulus to its production, and there is consequently no power to discern it in present-day civilization if it were produced; so that the best strength, if not the best intellect, of to-day is directed towards the solution of more material problems. The effect of this is to leave literary production, to an unprecedented extent almost, in the hand of the intellectually petty and the spiritually contemptible. Men who in periods of greater literary discrimination would not have achieved even the negative distinction of being ridiculed in satires such as those of Pope or Dryden, through lack of competition, get themselves considered authors, and the public is led to believe that, if they are condemned, literature with all the value and honor accorded to it by tradition must be condemned too. Some men of this type have entered college teaching and have thus been enabled to identify themselves with learning as well as with literature and to lessen the respect and sympathy of the student as well as that of the general public for the subject. It is to their influence that the student owes his impression that literature is a matter of form rather than substance, and that in it what is said is unimportant provided it be expressed in an elegant or striking manner. This leads to an esteem for mere felicity far beyond its worth and to a serious corruption of taste. What is known as "style" is certainly an important factor in determining literary values, but style is not a mere matter of the externals of expression, any more than being a gentleman is only a question of conventionalities of dress and deportment because it seems so to the petty mind.

Where this type of intellect does not identify excellence with externals or superficialities it is even more mischievous, for it inculcates a dislike for matter that is substantial and nutritive and a strong taste for what is stimulant or narcotic. Shakespeare and other writers that require depth of intellect and breadth of sympathy for their appreciation are abandoned, for the most part, to the philologists and pedants, or their greatness is explained as being due to skill in literary technique or to some secondary or inferior quality. That knowledge or wisdom is essential to good literature is entirely overlooked and very often the opposite is strongly implied. Understanding of life and its correct delineation is not what is presented as the aim of literature, but it is pictured as depending, in poetry, on a sort of mildly epileptic or neurotic excitement imparted by the writer to his verse so that the reader is infected by it; and in prose, on novelty and ingenuity. Classic literature is regarded as consisting of what persons of more solid attainments would call "minor verse"—verse dealing with sentiment rather than passion—and fiction; for in this school all prose that is literature is fiction, because facts are

too commonplace and uninteresting, as well as too difficult, for the elegant mind. The value of history, biography, especially of scientific exposition, while not denied openly, is tacitly belittled as a means of forming the intellect and imparting culture, even to scientific students. The effect of this on education has been very bad, for while the philologists and pedants have only helped to make literature ridiculous among undergraduates, this has done a great deal to bring it into contempt among them; for it is not lack of intelligence or refinement that makes the normal student dislike literature, so much as it is an instinctive realization on his part that, as presented by his teachers, it is nothing but effeminacy and snobbery. The student, on the other hand, who has pretensions to elegance and regards literature as something to be cultivated is unrestrained by any standards of sufficient dignity, and instead of being taught not to mistake license for liberty and appetite for aspiration, he is encouraged to do so, and it is said that in some of the larger colleges, where the fashionable element is most numerous, Oscar Wilde, whose appeal is only to the shallow or the corrupt, is the favorite author and the commonest model.

Materialistic preconceptions, therefore, have taken from the intellect of to-day both interest in literature and ability to understand its most characteristic qualities, and have allowed its production and interpretation to fall into the hands of persons who have misrepresented it, so that the misunderstanding of its nature by the public is not to be wondered at. The same preconceptions have identified the typical scientist with the inventor of an automatic annunciator or cash register, rather than with the discoverer of cosmic principles or far-reaching truth, and so have spread an impression that science is of the earth, earthy, while literature is vague, unsubstantial and sentimental. This being the situation, the question arises whether or not anything can be done to remedy it.

The bringing about of the production of enduring literature and the imparting to the public of an ability to detect and appreciate it is too great a task to attempt, and circumstances must be left to effect it. There is every reason, however, to expect a betterment in both these respects soon; for the maturing of American civilization has supplemented the former flamboyant and frothy public opinion with an undercurrent of serious and candid judgment, and has made the national conscience in this country more acute and more earnestly intent on discerning its own weaknesses and reforming them than it is anywhere else in the world. This would of itself presage the production of more serious and more important literature and the development of greater powers of discrimination, even if the deficiency in both these respects in the past generation did not ensure an improvement in the next. But this is only a prospect and applies only to literature; it still remains to be seen what can be done for the present, and what improvement can be wrought in the popular attitude towards science.

In this latter problem it would seem that most can be done by the scientific men themselves. It ought to be possible for them to visualize their own objects, and to define their own standards more clearly than they do. It often seems as if they were very punctilious about an etiquette that forbids them to profess any opinions on matters outside their own special field of knowledge. This appears as if it should be a good thing, and it would be beneficial if it were due to modesty alone or to a disinclination to speak without knowledge; but, unfortunately, it is due to a lack of interest more than to anything else; and its effect is, first, to present few exhibitions of the aims of science apart from those of the special investigator, which are necessarily restricted and preponderatingly material; and, second, to allow a great deal of pseudo-science to go unexposed to a sufficient extent to destroy its influence on the public mind. Instead of their present indifference, and sometimes suspicion and disdain, for all other knowledge except their own special branch, if scientific men would cultivate wider sympathies and endeavor to interest themselves in the progress of science in its entirety and not identify it

with their own specialty alone, it is likely that the public would acquire a more intelligent idea of what its essentials are, and a greater power to discriminate between those who represent and those who misrepresent it. With a united and sensitive scientific opinion, variations in either direction from its golden mean would be much more quickly detected and much less successful in obtaining public credence than they now are. The building of vast and elaborate structures of theory on microscopic foundations of fact would not escape scrutiny to the extent that it does now, and the pedagogist who promulgates his principles on the evidence of random, silly, or morbid statements gleaned from questionnaires, as well as the anthropologist who determines ethnic relationships on a few insignificant facts and his own racial or intellectual prejudices, or classifies the human race on the evidence of five or six skulls, and all similar empirics would have to find another livery than that of science to wear. Likewise, if a man should attempt to make history, philosophy, literature and kindred subjects exact sciences by some such simple expedient as measuring the amount of commentary on men and events to determine their importance, his plan would very soon be dismissed permanently as merely an effort to reduce an intensely complicated problem to a simple matter of sense perception—a thing that men will always try to do, just as they have sought the fountain of youth, the philosopher's stone, and more lately perpetual motion, but in doing so have shown themselves not scientific, but the reverse of it.

Another thing that might be done is to define more clearly the relation between theoretical and applied science. The general opinion now seems to tend altogether too much in the direction of believing that a choice must be made between them, and that to believe in the value of the one implies condemning the other. Of course there can be no intelligent condemnation of applied science, for theoretical science has no value apart from its application at some time or other; but what can be condemned is the prevalent idea that applied science is everything, and that if research or investigation can not be shown to have direct bearing on some problem of practical life it is valueless. This is a notion that scientific men owe it to themselves to combat and to overthrow. Let applied science have its honored place, let it be admitted that James Watt, even that the inventor of a useful mouse-trap, is a scientist; but let it also be recognized that Newton and men of his type deserve the title likewise, and that applied science owes something to their efforts and should be willing, not only to acknowledge the debt, but also to perceive the grounds on which it is due. Perhaps if this were done there would be less of what Professor Walker[2] has called "the spirit of alchemy" among present-day scientists, and there might also be a more intelligent idea of the nature of science abroad in the land—a realization that it means first of all a love of truth to which not only subjective hopes of immortality, and beloved traditions and beliefs, but even the love of profit itself must be subordinate.

Extending their sympathies and interests beyond the bounds of their own sphere of knowledge might also enable scientific men to aid somewhat in bringing about a better understanding of the real significance of literature. At present they, for the most part, regard the subject as a necessary evil to be suppressed as much as public opinion will permit. Others believe that it has some value, and although they can not make themselves see just what it is, they are nevertheless willing to take it on trust. Still others express great admiration for the subject, but their utterances concerning it often suggest that their understanding of it is not very profound. A saving remnant, however, show an intelligent appreciation and understanding of literature, and not less by what they reprehend than by what they praise, prove themselves its friends. It is this latter class that more catholic sympathies would undoubtedly increase; and with scientific opinion having the weight it has to-day, its influence on the public mind ought to be very great. On the academic world its influence should be even

[2] "Alchemy in Modern Industry," SCIENCE, N. S., Vol. XXXIII., p. 913.

greater, and ought to be sufficient to bring about a distinct betterment in the teaching of literature. It would be far better not to teach the subject at all than to do so in an ineffective or misleading manner or to treat it as a nuisance tolerated only to avoid the reproach of neglecting the cultural, without any faith either in the necessity for culture or in the study of literature being a means of acquiring it. An intelligent and interested opinion would do away with this situation, and would be sufficient to ensure literature being taught in a sincere and competent manner. Two things would undoubtedly be insisted on that are matters of indifference now: sufficient knowledge and sufficient persuasive power in the teacher. Literature is a subject that involves a knowledge of history and of languages, and no man has a right to teach it unless he can show a certain amount of learning in both fields; and to guarantee that he is not a pedant, he should be able to interest students in his subject and make it appeal to them. There is a very strong feeling now that instruction must not be allowed to degenerate into mere entertainment, and while there is some justification for this apprehension, it should not lead to the conclusion that any teaching that is dull or repellant is successful. Where real knowledge of wide significance is being conveyed there is no danger of the learner finding no resistance to overcome, but, on the other hand, there is no danger of its exposition becoming an insufferable bore or an object of ridicule among earnest and industrious students. There can be no doubt that if scientific opinion were more active and more general in its scope, not science and literature alone, but many other things as well, would become clearer in the public mind as well as more effectively treated educationally.

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THE NUMBER OF STUDENTS TO A TEACHER IN STATE COLLEGES AND UNIVERSITIES

The following tabulations are based upon figures found in "Statistics of State Universities and other Institutions of Higher Education partially supported by the State"[1] and show the number of students to a teacher in eighty-one state-supported schools.

The average number of students to a teacher is 10.5. It is interesting to note that while no doubt, in general, the cost of the unit hour of instruction is smaller in schools having more students to a teacher, the best schools in the list tend to have less than 10.5, the average number of students to a teacher. Thus for Cornell University the universities of Wisconsin, Illinois, Michigan, California and the Massachusetts Institute of Technology the number of students to a teacher is only 9.5 +.

Name of Institution	No. of Students to a Teacher
Alabama Polytechnic Institute	11.6
University of Alabama	11.3
University of Arizona	4.7
University of Arkansas	9 +
University of California	12.9 +
University of Colorado	7.8 +
State Agricultural College (Colo.)	3 +
Colorado School of Mines	18.7
Connecticut Agricultural College	8 +
Delaware College	6 +
University of Florida	7 +
Florida State College for Women	10.9 +
University of Georgia	11 +
Georgia School of Technology	12.3 +
North Georgia Agricultural College	14.2 +
University of Idaho	9.8 +
University of Illinois	8.4 +
Indiana University	13 +
Purdue University (Ind.)	11.2 +
Iowa State College of Agriculture and Mechanic Arts	12.4 +
State University of Iowa	13 +
University of Kansas	11.2 +
Kansas State Agricultural College	12.1 +
State University (Ky.)	9.7
Louisiana State University and Agricultural and Mechanical College	10.4 +
University of Maine	9.2 +
Maryland Agricultural College	7.7 +
Massachusetts Agricultural College	8.5 +
Massachusetts Institute of Technology	6.6 +
University of Michigan	15

[1] For the year ended June 30, 1910. Washington, Government Printing Office, 1911.

Michigan State Agricultural College	11.6 +
Michigan College of Mines	8.8 +
University of Minnesota	26.1 +
Mississippi Agricultural and Mechanical College	16.6 +
University of Mississippi [2]	12.6 +
University of Missouri	8.4 +
Montana College of Agriculture and Mechanic Arts	8.3 +
Montana State School of Mines	6.7 +
University of Montana	6.4 +
University of Nebraska	11.3 +
University of Nevada	8.3 +
New Hampshire College of Agriculture and Mechanic Arts	6.8 +
Rutgers College (N. J.)	9.3 +
New Mexico College of Agriculture and Mechanic Arts	8.2 +
University of New Mexico	8.1 +
New Mexico School of Mines	6.5
Cornell University (N. Y.)	6.6 +
University of North Carolina	8.2 +
North Carolina College of Agriculture and Mechanic Arts	10.4 +
North Dakota Agricultural College	11.5 +
State University and School of Mines (N. Dak.)	9.2 +
Ohio University	19
Ohio State University	12.8 +
Miami University (Ohio)	10 +
University of Oklahoma	10.9 +
Oklahoma Agricultural and Mechanical College	11.8 +
Oregon State Agricultural College	11.9 +
University of Oregon	8.6 +
Pennsylvania State College	9.5 +
Rhode Island State College	6.6 +
South Carolina Military Academy	17.9 +
Clemson Agricultural College (S. C.)	13.5 +
University of South Carolina	10.5 +
South Dakota Agricultural College	8.6 +
South Dakota State School of Mines	3 +
University of South Dakota	9.6 +
University of Tennessee	6.5 +
University of Texas	18 +
Agricultural and Mechanical College of Texas	16.1 +
Agricultural College of Utah	12.1 +
University of Utah	12.1 +
University of Vermont and Agricultural College	5.5 +
Virginia Polytechnic Institute	7.9 +
University of Virginia	10.5 +
Virginia Military Institute	16.3 +
College of William and Mary (Va.)	12 +
State College of Washington	13.9 +
University of Washington	18.5 +
West Virginia University	6.5 +
University of Wisconsin	7.9 +
University of Wyoming	5.6 +

[2] From 1909 report.

C. H. HANDSCHIN

SCIENTIFIC NOTES AND NEWS

IT is reported from Stockholm, we hope correctly, that the Nobel prize for physics will be awarded this year to Mr. Thomas A. Edison.

PROFESSOR R. W. WOOD, of the Johns Hopkins University, has been elected a corresponding member of the Göttingen Academy of Sciences.

PROFESSOR R. DEC. WARD, of Harvard University, and Mr. C. G. Abbot, of the Smithsonian Institution, have been elected corresponding members of the German Meteorological Society.

DR. EMIL FISCHER, of Berlin, has been awarded the Berzelius medal of the Swedish Medical Society.

PROFESSOR MARTIN KIRCHNER, the bacteriologist, has been appointed head of the medical department in the Prussian ministry, a position that has hitherto been held by a jurist.

SIR ALMROTH WRIGHT has been commissioned by the mining groups of the Rand to investigate and report on the question of immunization against pneumonia, a disease which is said to be the cause of the largest mortality among the native laborers on the goldfields.

DR. WILLIAM H. BROWN, research assistant in plant physiology at the Michigan Experiment Station, and instructor in plant physiology at the college, has been appointed plant physiologist in the Philippine Bureau of Science, Manila.

DR. YABE, formerly of Yokohama, is spending several months in the paleontological laboratory of Columbia University studying American Paleozoic faunas and also continuing his research on Scaphites.

Mr. Gano Dunn has returned from abroad, where, as a representative of the United States government and as president of the American Institute of Electrical Engineers, he has been attending the International Electrical Congress at Turin and the meeting of the International Electrotechnical Commission, the body that has been organized to bring about international uniformity of standards and practise in the electrical industry.

We learn from the *Electrical World* that Dr. Adolf Franke, director of Siemens & Halske Actien Gesellschaft, Berlin, arrived at New York on October 13, and will represent the Verband Deutscher Electrotechniker at a Helmholtz celebration which will take place under the auspices of the American Institute of Electrical Engineers. Dr. Franke is accompanied by Dr. A. Ebeling, chief of the Pupin department of the Siemens & Halske Company, known for his researches in connection with the Pupin system and the design of telephone lines. Later these gentlemen will be joined by Dr. Paul Rasehorn, chief of the electrical measuring department of the Siemens & Halske Company. These gentlemen will, in company with Dr. K. G. Frank, American representative of their company, visit a number of the more important telephone installations in this country and also make a study of the effect of high-tension transmission lines on neighboring telephone and telegraph lines.

We learn from the *Yale Alumni Weekly* that Professor Harry W. Foote, the naturalist on the Yale Peruvian expedition, has returned from South America with a valuable collection of zoological specimens including a large number of insects. He reports that the other members of the expedition, Professors Bingham and Bowman, are in good health and are having a successful field season. The party will be engaged until January studying a section of the seventy-third meridian from the base of the Andes to the Pacific Ocean.

Dr. M. P. Ravenel, of the University of Wisconsin, has left for New York City, where he will attend the second meeting of the National Commission on Standards of Milk. While in New York Dr. Ravenel will call a meeting of the board of directors of the National Association for the Study and Prevention of Tuberculosis of which he was elected president at the recent annual meeting in Denver.

Dr. Gilbert Ames Bliss, associate professor of mathematics at the University of Chicago, is giving a course in advanced mathematics at Harvard University for the current quarter.

Dr. Paul Lindner, of the Institute for Fermentation Industries at Berlin, gave an illustrated lecture on "New Views on Fermentation and the Fermentation Organisms" at the College of the City of New York on Tuesday, October 24, at 4 P.M., and at Columbia University on Wednesday, October 25, at 8:30 P.M.

Dr. Max Verworn, professor of physiology in the University of Bonn, lectured at Columbia University on October 26, on "Life and Death."

Dr. Thomas L. Watson, professor of geology, has been elected chairman, and Dr. R. M. Bird, collegiate professor of chemistry, secretary, of the scientific section of the Philosophical Society of the University of Virginia. The editorial committee, which will supervise the publications, consist of Dr. William H. Echols (mathematics), Dr. William A. Kepner (biology) and Professor L. G. Hoxton (physics).

Dr. J. Hughlings-Jackson, F.R.S., the eminent English neurologist, died on October 7, aged seventy-six years.

Professor August Michel-Levy, the distinguished French geologist, died on September 25.

The death is also announced of M. Alfred Binet, director of the psychological laboratory of the University of Paris.

The directors of the *Journal of Biological Chemistry* announce that the following friends and associates of the late Christian A. Herter have contributed to a Memorial Fund in recognition of his labors in promoting medical science: Mr. and Mrs. George F.

Baker, Mr. George B. Cooksey, Dr. H. D. Dakin, Dr. and Mrs. Edward K. Dunham, Mr. and Mrs. Richard M. Hoe, Mr. Alexander E. Orr, Mr. Cornelius N. Bliss, Miss Bliss, Mr. David Dows, Mr. Tracy Dows, Dr. and Mrs. L. Emmett Holt, Dr. Graham Lusk, Mr. Frederick Strauss. This fund, now amounting to forty thousand dollars, has been confided to the care of the directors of the *Journal of Biological Chemistry* under the provisions of a declaration of trust executed by them. The chief aim of the trust is to further the interests of the *Journal of Biological Chemistry*, an instrument for the development of science created by Christian A. Herter and fostered by him up to the time of his death. In the event that conditions arise removing the need for such a use of the income, provisions are made by which the fund shall continue as a memorial of Professor Herter and of service to humanity by the promotion of scientific research.

LECTURES given in the lecture hall of the Museum Building of the New York Botanical Garden on Saturday afternoons are as follows:

September 2—"The Berlin Botanical Garden," Dr. W. A. Murrill.

September 9—"Plants and People of Pinar del Rio, Cuba," Dr. C. Stuart Gager.

September 16—"The Fruit Industry of the Northwest," Mr. George V. Nash.

September 23—"The Vegetation of the Dismal Swamp of Virginia," Dr. Arthur Hollick.

September 30—"The Progress of the Development of the New York Botanical Garden," Dr. N. L. Britton.

October 7—"Some Scenic and Floral Features of Cuba," Dr. Marshall A. Howe.

October 14—"The Movements of Plants," Dr. C. C. Curtis.

October 21—"Some Types of Variegated Plants," Professor R. A. Harper.

October 28—"The Methods of Detecting Adulteration in Food and Drugs," Dr. H. H. Rusby.

THE new pathological institute of the Royal Infirmary, Glasgow, has been formally opened by Sir William Osler, as we learn from *The British Medical Journal*. The new building, which forms an important feature of the extensive reconstruction scheme of the Royal Infirmary, is situated in the eastern corner of the infirmary grounds and abuts on Glenfield Street. It is a fine building which reflects great credit on the architect, Mr. James Millar, who has already had experience of modern laboratory requirements in the new university medical extension. The feature of the institute is a large central hall, well lit by roof windows. Round the hall runs a gallery. The eastern end communicates with a large museum, consisting of a central well with two galleries. The museum is beautifully lit both by roof and side windows. Off the central hall open the various laboratories and research rooms. On the ground floor are laboratories for the teaching staff and a large general laboratory for research purposes. From the gallery entrance is gained to the lecture theaters, bacteriological laboratory, histology room, and the chemical laboratory, while a staircase gives access to the photographic room and library. At the western end of the building the *post-mortem* room, with a small chapel, etc., are situated.

Nature learns from a Sydney correspondent that the New South Wales government has issued instructions for the appointment of a state astronomer, who is also to be professor of astronomy in the Sydney University. At present it is said there is no chair of astronomy in Australia. In making this appointment, the public service board is acting with the university authorities, and they have fixed the salary at £800 per annum, with £100 for quarters; the professorship will carry with it the usual pension allowance. The first duty of the new state astronomer will be to organize the erection and equipment of a new observatory, as the present site is condemned.

MR. CHARLES E. GOODSPEED, of Boston, paid $2,000 for a copy of the elephant folio edition of Audubon's "Birds" at a recent auction sale of rare books by C. F. Libbie & Co. The copy of Audubon's "Birds" was in fine condition, with the large plates of the turkey full-size, and many other plates in practically uncut condition. This original edition contained 435 beautiful plates, colored by hand. The work was published by the author in London in 1827–38.

During the last two weeks of August some students of the summer session and graduate department of Columbia University made an extended excursion with Professor A. W. Grabau through New York State for the purpose of studying the various type sections of the Paleozoic series. The party numbered fourteen in all and included Professor C. E. Gordon, of Amherst; Dr. Yabe, recently appointed to the professorship of paleontology in the new university at Sendai, Japan, and Dr. Hahn, of Munich. Among the localities visited were Schoharie, Little Falls, Trenton Falls, Holland-Patent, the ravine of Swift Creek near Chadwick, a type section of the Clinton, the typical outcrops of the Oneida conglomerate, the Syracuse region, Tully and vicinity, the Genesee Gorge at Rochester and at Portage, Olean and the Rock City, Eighteen Mile Creek, and the Lake Erie shore, North Buffalo, Niagara, etc.

UNIVERSITY AND EDUCATIONAL NEWS

The Massachusetts Institute of Technology has broken ground for the Summer Engineering Camp at Gardner Lake, Me., near East Machias. The wooden permanent buildings will be erected as soon as possible in the spring and the whole camp will be ready for the summer course of the civil engineers early in August. The camp grounds, which have been presented to the institute by an anonymous friend, include more than a square mile of land at Crosby's Point, with outlook on the water on both sides and more than three miles of shore line. Mr. Charles W. Eaton ('84), of Haverhill, gave to the institute $10,000 for the purpose of erecting permanent buildings on this land.

On October 3 members of the faculty and students at the University of Chicago observed the nineteenth anniversary of the opening of the institution with commemorative chapel services in Mandel Hall. The services were opened with prayer by Professor C. R. Henderson. President Judson spoke on the work of the university and compared the institution when founded with that of to-day. In a comparison of present conditions with those obtaining nineteen years ago, it was recalled that when the doors were opened for instruction on October 1, 1892, the number of students registered was 594, as against 6,466 during the year 1910–11. The faculty at the start consisted of 135 men; now it numbers over 400. At its inception, the university owned four city squares of ground, and its total assets in pledges, endowment, buildings and books were $4,341,708. To-day its endowment and property holdings and pledges total $37,270,792.

Announcement has been made of the consolidation of Barnes Medical College, St. Louis, and the St. Louis College of Physicians and Surgeons. It is hoped that the combination may bring the institution up to the standard required by the State Board of Health.

At Goucher College, Baltimore, Dr. Samuel N. Taylor, formerly professor of engineering at the University of Cincinnati, has been appointed professor of physics, and Dr. William H. Longley, professor of biology.

Professor H. E. Jordan has been promoted to a professorship of histology and embryology at the University of Virginia.

J. Chester Bradley, Ph.D. (Cornell '10), has been promoted to be assistant professor of systematic entomology in Cornell University, to succeed Dr. A. D. MacGillivray, Ph.D. (Cornell '04), who has accepted a similar position in the University of Illinois.

A. J. Goldfarb, Ph.D. (Columbia '10), has been made an instructor in natural history at the College of the City of New York.

Mr. H. A. Wadsworth has been appointed assistant professor in the School of Forestry at the University of Idaho.

Dr. Dudley B. Reed, formerly director of physical education at the University of Rochester, has assumed his duties as medical examiner at the University of Chicago, succeeding Dr. J. E. Raycroft, who has gone to Princeton University as head of a new department of hygiene and physical education.

THE position of curator in paleontology at Columbia University, made vacant by the resignation of Dr. Elvira Wood, has been filled by the appointment of Felix Hahn, Ph.D., of Munich, who began his work at the university in August. Dr. Wood has gone to the Museum of Comparative Zoology in Cambridge.

DR. J. D. FALCONER, late principal officer of the Mineral Survey of Northern Nigeria, has been appointed to the lectureship in geography at Glasgow University, vacated by Captain Lyons, F.R.S.

DISCUSSION AND CORRESPONDENCE

TEXT-BOOKS AND REVIEWING

AMONG the numerous text-books which appear every year, some are critically and carefully reviewed, but others are treated superficially, or scarcely noticed. Without having compiled any statistics, I have the impression that the condition of affairs is on the whole very unsatisfactory, especially with regard to books intended for the secondary schools. Having for many years been interested in high-school biology, I have had occasion to look at many text-books and read many reviews, and it seems to me doubtful whether at the present time the high schools are protected, as they ought to be, from bad work. It may be said that the teachers themselves should know enough to avoid the use of badly written books, or to correct the errors in those which are on the whole meritorious; but any one acquainted with actual conditions will know that this is much more difficult than it seems. The one necessary thing is that responsible writers shall deal adequately and frankly with the books in responsible journals, making it impossible for anything unworthy to escape the criticism it deserves. Text-books stand on a somewhat different footing from other works. An original monograph may be praised for its good qualities, and its faults (there are always some!) forgiven. It is judged by the actual advance in knowledge it represents. A text-book should be scrutinized so carefully that all errors are eliminated, save those due to the unwitting ignorance of present-day science. Criticisms which may seem ungracious in respect to original works, are justifiable and necessary when dealing with text-books. I will even suggest that SCIENCE might do worse than open a column headed "errors in text-books," to which teachers should send signed notes pointing out the mistakes they find from time to time. These corrections would be especially valuable when concerning texts in constant use and of known merit.

The immediate occasion for these remarks is a book by Dr. E. Davenport, of the University of Illinois, entitled "Domesticated Animals and Plants" (Ginn & Company, 1910). A copy of this work reached us at the University of Colorado early in the present year, and was examined with more than usual interest, on account of the need for something of the kind in our high schools. It was seen to be of convenient size, well printed, pleasantly written, and well illustrated. However, about the first thing to strike the eye on turning over the pages was a good picture of a passenger pigeon, with the extraordinary statement that it is the "wild parent of all the domesticated sorts that have been developed by selection." On the next two pages are figures of twenty kinds of domestic pigeons, with these legends: "Types of pigeons developed from the rock or passenger pigeon shown in Fig. 13"; "Additional types developed from the passenger pigeon, by selection and breeding." This astounding information is outdone, if that is possible, by some of the definitions at the end of the book, as "*zygote*, that portion of the gamete which determines a unit character"; "*gamete*, the fertilized ovum or ovule." Fairly dizzy, we turn over a few more pages and discover that (p. 163) "every individual transmits all the characters of his ancestry," a statement considered so important that it is italicized. The amount of error in the book is well brought out by Mr. Richard Lydekker, who reviews it in *Nature*, March 23, 1911, p. 107. Taking up the one section on cattle and sheep (eleven pages) he finds a whole series of blunders,

which he enumerates in some detail. In short, the book is so inaccurate that it is an outrage to put it in the hands of a single immature student. This book has been pushed by active and intelligent agents, and also widely advertised; it has doubtless been adopted in many schools. How have the scholars of America dealt with it? The first review I saw was in the *Nation*, of course anonymous. It was laudatory, and did not indicate that anything was wrong; though I remember a vague reference to some matters on which there might be differences of opinion. I wrote to the editor, pointing out the real character of the book, and received the reply that the reviewer quite agreed with me as to the work *as a text-book*, but reviewed it favorably because he thought it might be useful in other ways!

For some time no other review came to my notice, until I received the *American Breeders' Magazine*, Vol. 2, No. 1. Here, if anywhere, we might expect critical treatment. The review (p. 77) is wholly and extravagantly laudatory, without any hint of errors. It ends with the remark that "Dean Davenport's pioneering work is most valuable, both because of the excellence of his books and because they blaze the trail in this subject." The review is anonymous, and the editor, on being written to, does not defend it.

Finally, I find a review by Dr. Geo. H. Shull in *Botanical Gazette*, September, 1911. Dr. Shull, as might be expected, tears up and scatters to the four winds the treatment of Mendelism, but says that it lacks "the definiteness and accuracy which characterizes the rest of the book," and again "It seems unfortunate that a book otherwise so admirable should propagate such definitions as these."

I should have had something to say on this matter earlier, but for the fact that Ginn and Company's agent, visiting me here, gave me to understand that the edition would be withdrawn and a corrected one substituted. After a time, suspecting that this was not being done I wrote to the publishers direct and was told (August 21, 1911) that "no revision of it has been called for or made." A later letter (September 4) stated that it was Professor Davenport's intention to make some changes and corrections which my earlier letters to the publishers had suggested. There is no indication whatever of any intention to withdraw the edition now on sale.

Other instances could readily be cited to show that vigilance is the price of accurate text-books. I will mention only one that came before me quite recently. Two books arrived in the same package from the American Book Company. One is Hunter's "Essentials of Biology," the other Sharpe's "Laboratory Manual for the Solution of Problems in Biology." The authors both teach in the De Witt Clinton High School. Hunter (p. 44) refers to the composite "flower cluster, so often mistaken for a single flower"; Sharpe (explanation to figure 6) does so mistake it, the legend reading "Curve of variation in number of petals of ox-eye daisy. . . . Number of petals to a flower on line *ac*."

T. D. A. Cockerell
University of Colorado

"AIR IN THE DEPTHS OF THE OCEAN"

To the Editor of Science: In a recent number (August 25) an explanation is offered by Carl Hering as to the supply of dissolved oxygen, necessary for the respiration of fishes, even at great depths in the ocean. The suggestion is that the solubility of oxygen in water, being proportional to the pressure, is much greater at considerable depths than at the surface, and therefore the dissolved oxygen diffuses readily downwards.

There is surely a confusion of ideas here regarding pressure. The pressure to which the solubility of oxygen is proportional is the (partial) gas pressure of oxygen; the great pressure in the ocean depths is hydrostatic, which has but a very slight effect on the solubility of a gas.

The solubility of oxygen, therefore, does not appreciably increase towards the bottom of the sea, but the ordinary process of diffusion from the saturated surface layers may well provide adequate oxygen even at the greatest depths, in view of its uninterrupted action and the

length of time during which it has been in operation.

I have delayed submitting this note in the expectation that others would be as ready to convey information regarding air in water as they have been concerning water in air!

Percy Norton Evans
Lafayette, Indiana,
September 18, 1911

THE INFLUENCE OF HEREDITY AND OF ENVIRONMENT IN DETERMINING THE COAT COLORS IN MICE

Professor T. H. Morgan,[1] in an interesting paper, has lately published the results of his breeding experiments with mice. Among other questions he considers certain curious coat patterns on black animals resulting from a black × chocolate (brown) cross.

Such coat patterns, which appear to consist of well-defined regions of light and dark hair, he considers due to heterozygosis between the black and brown coat colors.

That such patterns are not due to heterozygosis of black and brown is, I believe, shown by the following three facts which I have been able to record:

1. That in mice, brown (chocolate) animals may possess these coat patterns while changing coats. These animals are by experiment proved to be free of all black pigment.

2. That in rabbits, black animals may show these coat patterns with extraordinary clearness. There is no brown (chocolate) rabbit recorded.

3. That the common gray squirrel frequently shows distinct coat patterns of this nature, when changing coats. This wild species is undoubtedly homozygous for its color pattern.

Morgan further suggests that these coat patterns in mice may be due to heterozygosis of intensity and dilution of coat pigmentation. This, I think, is disproved by the fact that I have obtained clearly defined patterns on the coats of dilute pink-eyed brown (chocolate) mice. These animals are the lowest recessives in the series of colored mice. They have been found, by experiments, to lack the ability to produce black pigment, intensity of coat pigmentation and dark eyes.

[1] *Annals N. Y. Acad. of Science*, 1911, Vol. XXI., pp. 87–117.

It would seem then that the coat patterns recorded by Morgan as well as those mentioned above are the result of physiological conditions of the animals incidental to the coat-changing period, and that they can not be considered of any value as indicating the gametic composition of the animal on which they appear.

C. C. Little
Bussey Institution,
Harvard University,
October 5, 1911

QUOTATIONS

CONGRESS OF THE UNIVERSITIES OF THE BRITISH EMPIRE

A further meeting of the vice-chancellors of the home universities who constitute the Home Committee to make arrangements for the Congress of the Universities of the Empire, which is to be held in London next year on July 2, 3, 4 and 5, was held recently at the University of London under the chairmanship of Sir William Collins, vice-chancellor of that university. The meeting was also attended by Sir Charles Lucas, head of the Dominions Department of the Colonial Office; Sir Theodore Morison, a member of the Council of India; and Dr. Heath, of the Board of Education. In November last year an invitation was extended to the fifty-one universities in the British Empire to send representatives to the congress, accompanied by an intimation that the topics to be considered would fall under the following heads, but inviting suggestions: (1) University organization; (2) universities in their relation to teachers and undergraduate students; (3) universities in their relation to post-graduate and research work; and (4) universities in their relation to schools and to agencies for higher education. At the recent meeting the suggestions received from oversea universities were considered, and Dr. R. D. Roberts, secretary to the congress, made a report upon a preliminary conference of representatives of the Canadian universities, held at Montreal

last summer, which he had attended. The congress, which was summoned by the Principals of McGill University and the University of Toronto, was attended by representatives of fifteen of the nineteen universities in the Dominion. The representatives of the universities of Alberta and Manitoba were prevented from attending at the last moment, and only two of the smallest universities failed to accept the invitation. Dr. Roberts reported that in addressing the Canadian conference he had instanced, as a few of the questions which seemed to be demanding attention, the following: The first was whether any common understanding was possible among the universities of the empire as to the extent to which they could recognize each other's entrance examinations; another was the desirability of increased facilities for post-graduate study; a third, the possibility of some plan for interchange of professors; a fourth, what could be done by universities in regard to the after-careers of their students. There was, further, the whole question of the financial support given from public sources to universities in the British Empire, as compared with the provision for university education made in other countries. There was finally the suggestion, made by Principal Peterson and others, that a central bureau should be formed to furnish information to the universities of the empire upon these and other questions. The principal of Toronto University reported that it had appointed a committee which was carefully considering the list of subjects which should be brought before the congress, and the conference finally decided to appoint three committees, one for the western provinces, another for the maritime, and a third for the central provinces. In conclusion Dr. Roberts stated that from conversations with the heads and professors of universities in the eastern parts of Canada, which alone he had leisure to visit, he had formed the impression that the question of enlarged facilities for post-graduate study was regarded as of prime importance from the Canadian point of view. The University of Sydney has appointed Earl Beauchamp, formerly visitor of the university; Professor Anderson Stuart, dean of the faculty of medicine; Professor Warren, dean of the faculty of engineering, and Mr. H. E. Bartff, registrar, as delegates to represent it at the congress next year. The Home Committee has appointed a subcommittee to draw up a detailed program for the consideration of a meeting of the full committee on November 4. Inquiries with regard to the congress should be addressed to Dr. R. D. Roberts, at the Congress Office, University of London, South Kensington, London, S. W.—*British Medical Journal.*

TECHNICAL JUDGES

JUDGES continue to protest against the absurdity of their being called upon to pass upon highly technical and scientific questions. Thus Judge Hand, in the course of an opinion which he rendered in a case involving patents in the manufacture of chemicals, took occasion to remark:

"I can not stop without calling attention to the extraordinary condition of the law which makes it possible for a man without any knowledge of even the rudiments of chemistry to pass upon such questions as these. . . . In Germany they do quite differently. There the courts summon technical judges to whom technical questions are submitted and who can independently pass upon the issues without blindly groping among testimony wholly out of their ken. How long we shall continue to blunder along without the aid of unpartisan and authoritative scientific assistance in the administration of justice, no one knows, but all fair persons not conventionalized by provincial legal habits of mind ought, I should think, to unite to effect some such advances."

The need of such a reform as Judge Hand here urges has often been argued. We should not forget, however, that it is possible to meet the difficulty, in part at least, by extra-judicial means. In point is the plan favored by the New York Chamber of Commerce for settling commercial disputes by arbitrators selected from an official list. This plan provides for the disposal of technical questions arising in business by men peculiarly qualified by rea-

son of their experience. As the list covers men in all lines of business and industry, it is no longer absolutely necessary to submit such questions to untrained jurors, or to judges without special fitness to pronounce upon them.—New York *Evening Post*.

SCIENTIFIC BOOKS

Life and Scientific Work of Peter Guthrie Tait. By DR. C. G. KNOTT. Cambridge University Press. 1911.

The volume before us supplements the two volumes of "Scientific Papers" published by the same press in 1898 and 1900, under the supervision of Tait himself. For the preparation of this volume Professor Knott was well qualified, having been a pupil, colleague and friend of Tait; and he has made excellent use of the material placed at his disposal, giving full and interesting information about the relations of Tait to the other great mathematicians and physicists of his time.

The author does not follow the chronological order, but divides his material with some logical redundance as follows: Chapter I., Memoir; II., Experimental Work; III., Mathematical Work; IV., Quaternions; V., Thomson and Tait's Natural Philosophy; VI., Other Books; VII., Addresses, Reviews and Correspondence; VIII., Popular Scientific Articles. Appended is a bibliography of Tait's writings.

In his early years Tait became enamored of pure science, and he clung to that ideal throughout life. He was a very brilliant pupil at the Edinburgh Academy, where he had Maxwell for schoolmate and special friend; he did not, like Maxwell, study at the University of Edinburgh, but went straight to the University of Cambridge, where he graduated as senior wrangler; he was for six years professor of mathematics at Belfast, and for forty years professor of natural philosophy at Edinburgh. His manner of life at Edinburgh was simple. During the winter term he was much occupied with lecturing, in which he was singularly clear and inspiring; during the summer term he devoted much time to experimental investigation in the laboratory; the long and the short vacations he spent at St. Andrews, where there is a famous golfing course; both summer and winter it was his custom to work to late hours in his library.

One of the most elegant of Tait's investigations, combining mathematical, experimental and technical skill, dealt with the phenomena of golf. I remember that when I was an instructor in the laboratory, American students used to describe the curves of a baseball and ask for the explanation; I doubt whether Professor Tait at that time could give an adequate explanation. But it is different now; his investigation of the path of the golf ball applies also to the phenomena of baseball and of tennis, and is full of interest to scientific players.

Tait's greatest contribution to mathematical analysis undoubtedly consists in his advocacy and development of the quaternion method invented by Hamilton. At the time when Hamilton was about to publish his "Lectures on Quaternions," his friend De Morgan suggested the names of a very few mathematicians on whom a presentation copy would not be thrown away; one of these was Professor Thomson, afterwards Lord Kelvin. Doubless the advice was acted on, but for some reason Thomson formed an unfavorable opinion, to which with his characteristic tenacity he clung ever afterwards. On the other hand, Tait, having just graduated, was curious enough to buy a copy, and on perusal became convinced that the method contained possibilities of highly useful application to mathematical physics. It was through Tait that Maxwell became an earnest student, and it is evident from the correspondence here printed that Maxwell was one of the first vector-analysts. The book before us throws much light on the relations of these three great Scotsmen to one another, and on the relation of Tait to Hamilton.

The fifth chapter gives authentic information about the preparation of the celebrated "Treatise on Natural Philosophy." The idea was due to Tait, and some advance in its realization had been made before Thomson

entered as partner. The plan then adopted contemplated four volumes, two to be written by each. Tait speedily wrote the first volume, and had the great benefit of Thomson's advice and revision; but Thomson did not immediately tackle the labor of writing the second volume, and after some years it was impossible for him to sit down to such a task on account of the other exacting labors which he had undertaken. As one of his most distinguished pupils said, Thomson was no writer of text-books. In consequence the other three volumes were never written. I believe that Thomson was to have written on Electricity and Magnetism, and Tait on Heat and Light. When a second edition of the first volume was called for the matter was extended into two separate parts, mainly from additions contributed by Thomson.

The remaining chapters show that Tait wielded the pen of a ready writer. His library was largely his workshop. Like Maxwell, he could turn out good verses. Much that he wrote was controversial in nature; and, being apt to take an extreme view, he was sometimes wanting in logical consistency. All the same, he was one of the very great mathematical physicists of the Victorian age; and the ultimate verdict of the future will, I believe, place him second only to Maxwell.

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Chemistry of Food and Nutrition. By HENRY C. SHERMAN, Ph.D., Professor in Columbia University. New York, The Macmillan Co. Pp. viii + 355. 1911. Price $1.50.

In the preface to this volume the author makes the following statement: "The present work is the outgrowth of several years' experience in teaching the subject to collegiate and technical students who have represented a considerable diversity of previous training and points of view, and, while published primarily to meet the needs of the author's classes, it is hoped that it may also be of service to students and teachers elsewhere and to general readers whose main interests may lie in other fields but who appreciate the importance of food and nutrition as factors in hygiene and preventive medicine." The clear, thorough, modern and unbiased presentation of the fundamental facts and theories of nutrition, given in this text-book, should give it a necessary and permanently useful place in the instructional work of our American universities, and should also make it a valuable and convenient source of information to the general reader desiring accurate knowledge in this important and vital subject. This text might well be extensively used in our agricultural colleges as a prerequisite for the courses in animal nutrition that are as yet often inadequately taught to students in agricultural courses.

The eleven chapters of this book are devoted to the following subjects: the organic foodstuffs, the general composition of foods and action of ferments, the course of the food through the digestive tract, the fate of the foodstuffs in metabolism, the fuel value of food and the energy requirement of the body, conditions affecting the total food requirements, protein metabolism and the protein requirement, food habits and dietary standards, iron in food and its functions in nutrition, inorganic foodstuffs and the mineral metabolism, and criteria of nutritive value and economy of foods. The appendix contains tables showing (*a*) the edible organic nutrients and fuel value of foods, together with the weight in grams of the portion which would supply 100 calories; (*b*) the ash constituents of foods in percentage of the edible portion; and (*c*) the ash constituents of foods in grams per 100 calories of edible food material. The complete index to the text will materially aid the reader in finding what he wants, and the numerous references to the original literature will enable the advanced student to acquire a first-hand knowledge of the facts and theories of the science of nutrition.

The subject matter given in the chapters entitled the fuel value of food and the energy requirement of the body, conditions affecting the total food requirements, protein metabolism and the protein requirement, food hab-

its and dietary standards, inorganic foodstuffs and the mineral metabolism, and criteria of nutritive value and economy of foods, is of the greatest importance, and the reviewer believes that the views presented are in the main fundamentally sound, and that they will have an important influence in assisting the advanced student and investigator in arriving at correct conclusions upon these questions of nutrition.

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Zoologisches Addressbuch. Namen und Adressen der lebenden Zoologen, Anatomen, Physiologen und Zoopalæontologen sowie der künstlerischen und technischen Hülfskräfte. Herausgegeben auf Veranlassung der Deutschen Zoologischen Gessellschaft. 2 vollständig und bearbeitete Ausgabe. Berlin: R. F. Friedländer & Sohn. 1911. Pp. 1109. M. 15.

Biologists throughout the world are greatly indebted to the German Society of Zoologists and to the enterprising firm of Friedländer & Sohn in Berlin for this very substantial aid to research. The first edition of this zoological directory was issued in 1895, and a supplementary volume in 1901. The decade that has passed since the last supplement was published has brought many changes in the personnel, distribution and lines of interest of the biological contingent of the scholarly world, so that this new edition is particularly welcome at the present time. The work gives the correct address, official or educational connections and specialty of nearly 17,000 persons having professional or sufficient amateur interests in some field of biology to justify their inclusion in a list of zoologists. The names of a few of the leading booksellers, dealers in animals, and supply houses are included, but this element is far from complete. The lists also include, as before, the titles of the various natural history societies, museums, academies, etc., with official address, name and address of the secretary, and titles of serial publications with the date of the initial volume, a feature of great value to librarians, bibliographers and to the exchange service of scientific organizations conducting publications.

A new feature in the present volume is the inclusion of the addresses of all the various European organizations for bird protection, and of the local clubs of entomologists, ornithologists, and other amateur organizations of naturalists. In Berlin, for example, we find the "Hertha," "Nymphæa alba" and "Triton" Vereine für Aquarien- und Terrarienkunde, each with its stated hotel or restaurant where its social gatherings are held. The abundance of such organizations in Germany and Great Britain stands in noticeable contrast to their rarity in our own country. This contrast is, in a manner, an index of the smaller interest taken in this country in the study of animals, as a result possibly of the absence of instruction in natural history in our secondary schools and universities and of the predominance of the commercial spirit.

As an original document in the history of the biological sciences this volume is of particular interest as it marks (in a unique fashion) the progress of the growth of interest throughout the world in biological matters. The edition of 1895 contained about 12,000 names as over against the 17,000 of the present one. The supplementary volume of 1901 is too incomplete for comparison.

The work is international in scope and the growth here indicated is shared by all nations, though somewhat unequally. The increase in names is approximately fifty per cent. in the past fifteen years. The greatest gains, computed on the basis of pages devoted to the countries in question in the editions of 1895 and 1911, have been made in those countries which were in the lead in the earlier years. Thus, for example, Germany makes a gain of 128 per cent., Great Britain, the United States, Austria, Switzerland, exhibit gains of 80 to 90 per cent., while Russia, Belgia, Denmark and Canada show even larger growth, 100 to 110 per cent., and Japan the unsurpassed record of 170 per cent. The Latin countries have smaller increments to their

credit: Italy, 58 per cent., Spain, 40 per cent., France but 20 per cent., Mexico, 33 per cent. and South America, 31 per cent. India, China and Africa all make creditable gains, but Australasia appears to be at a standstill.

The changed political conditions in Europe are reflected in the fact that Turkey appears in the list for the first time and in the considerable gains in the Balkan states. On the other hand, the inroads of despotism are evident in the significant entry "Suspend," after not a few noted and promising names in the official staffs of the Russian universities.

It is inevitable that omissions, errors and inequalities of standard will creep into such a work, where the editor so necessarily is dependent upon voluntary assistance. The American section seems especially to have needed critical revision, for it contains numerous antiquated entries, inequalities in representation, and some positive errors. The Rockefeller Institute is, for example, credited to Chicago! One also misses in this new edition, the very helpful subject index of specialists of the earlier editions. The size of the volume would have been somewhat increased thereby, but the increased cost would have been more than compensated for by the greater usefulness of the work to the specialist seeking the names of his fellow-workers. The citation of specialty in connection with the alphabetical index of names would be a welcome addition to the work. In spite of these minor defects, however, the work will be exceedingly useful to every biologist and naturalist who seeks information regarding the organization and personnel of the various departments of the biological sciences throughout the learned world.

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THE PRIBILOF FUR SEAL HERD AND THE PROSPECTS FOR ITS INCREASE[1]

After more than twenty years of active operation, the pelagic sealing industry has been brought to an end, as the result of a convention which has been signed by representatives of the United States, Great Britain, Russia and Japan, and ratified by the Senate of the United States.

The contracting parties have agreed to prohibit their vessels from engaging in pelagic sealing and to close their ports against all vessels connected in any way with the operations of pelagic sealing. It is not necessary in this connection to go into the details of the seventeen articles of the convention, which is to continue in force for a period of fifteen years from December 15, 1911.

The total loss of seals from the North Pacific herds through pelagic sealing since its inception may be placed at about three millions. As a large proportion of this catch consisted of females, the disastrous effect upon the breeding stock of the Pribilof and Commander Islands will be readily appreciated.

The fur-seal industry, both at sea and on land, was for many years the subject of almost continuous international controversy, and the Pribilof herd especially has been studied long and carefully by commissions selected chiefly from the ranks of British and American naturalists.

The facts respecting the fur seal's habits, migrations, food, breeding, growth, age, numbers, anatomy, enemies, etc., etc., as arrived at by the commissions appointed to study the subject in general, afloat and ashore, can not reasonably be questioned. They are based upon prolonged inquiry by representatives of the two countries most interested, and have been mutually accepted only after the keenest possible criticism from both sides.

The natural history of the fur seal is now better understood in detail than that of any other wild mammal. These investigations, commenced about twenty years ago, have yielded much new information, and, with the cessation of pelagic sealing, we are now ready to apply scientific methods to the rehabilitation of the small herd remaining on the Pribilofs with full confidence as to the result.

The polygamous habit of the fur seal is the principal fact with which we have to deal in considering any scheme of management of

[1] Read at the forty-first annual meeting of the American Fisheries Society, October 3, 1911.

this animal upon its natural breeding grounds. Each mature male controls from 1 to 100 females, the average number of females in the harems, into which the rookeries are divided being about thirty. The surplus of male seals naturally resulting from the polygamous nature of the fur seal is large, and the most of it has always been available for commercial purposes.

The male seals are thus of two distinct classes: the adults in possession of the breeding grounds, and the immature males located entirely away from such grounds. The latter do not acquire the size and courage to fight their way among the large breeding animals until about seven years old, although otherwise mature at the age of four years.

During the breeding season the mature males are in possession of the harems, where they maintain their positions by sheer fighting ability. Their courage is such that they do not give way even before men armed with heavy clubs, and it is dangerous for men to attempt to enter the rookeries at this time. When the males seize each other with their powerful jaws they frequently tear rents in their thick hides. In a quarrel for the possession of a female, the latter may be frightfully lacerated, and is sometimes killed. Fighting may be seen anywhere in the rookeries and many of the very young seals are trampled to death.

The destruction of young through the fighting of the bulls is of serious extent even when large numbers of surplus males are annually killed for marketable skins. It must have been vastly more serious, prior to the utilization of seal skins by man.

It is the belief of naturalists who have studied the fur seal on its native islands that the furious fighting of the males upon the breeding grounds actually constituted nature's check to the unlimited increase of the race. It could have been nothing else, although the worm parasite (*Uncinaria*) of the sand areas must be considered to some extent in this connection.

Prior to the discovery of the Pribilofs the breeding grounds were undoubtedly overflowed at times by such hords of mature males that an important proportion of the young of the year, and many adult females, were destroyed.

There can be no doubt that the annual reduction of the male surplus for commercial purposes since the discovery of the islands has greatly lessened the breeding-time turmoil of the rookeries, and that proportionately larger numbers of young survive the perils of infancy.

Now that pelagic sealing, so wasteful of the adult female life, has been suppressed, we may expect an annual expansion of our shrunken breeding grounds.

The male stock on the islands should be watched with care and its numbers kept within safe bounds. A sudden increase of fighting males in the rookeries at a time when the stock of females has reached the lowest limit in the history of the island would greatly endanger the newly born young.

Here we may take up a matter of importance to this society. A resolution was introduced in the House of Representatives on August 12 to provide for the suspension of all seal killing on the Pribilofs for a period of fifteen years. This resolution may come up for consideration when Congress convenes. Its passage would be unwise in many ways, but chiefly in the danger of a rapid increase in fighting male seals which it would bring about. While a cessation of land killing for a season or two might cause no serious trouble, the fifteen-year period specified is not only too long, but positively dangerous, as the Bureau of Fisheries would be powerless to apply the necessary remedy for the evil of overcrowding by males when it becomes serious.

The criticism of the administration of the seal islands which called forth the above resolution of August 12, 1911, was made by men who have not been on the islands for twenty years and who can not appreciate the recent detailed investigations. Severe criticisms have also been made by men who have not been there at all, and whose opinions upon the subject are of little value.

Plans have been considered for reducing the loss through the hook-worm *Uncinaria*. The

breeding grounds of the Pribilofs are located largely upon rocky ground or upon firm soil and have sufficient slope as a rule to prevent the accumulation of sand. There are small sand patches within the limits of several rookeries which are infested with the parasite *Uncinaria*. This hook-worm is one of the contributing causes to heavy annual losses among the young seals born on sandy areas. The *Uncinaria* parasite was doubtless a greater source of danger in former years than at present. It was, like the fighting of the males, a natural check upon the unlimited expansion of the seal herd, but not so potent. The topography of some of the rookeries is such that an extension of their limits would force the breeding females to occupy unfavorable sandy areas. This source of danger to young seals can be eliminated, if sandy ground is covered with rock, or fenced in so that breeding seals can not occupy it.

In conclusion it may be stated that with our present knowledge of the life history of the fur seal, there is no reason why our valuable herd should not only rapidly increase in size, but, under wise management, *actually exceed in numbers* the great herd occupying the Pribilof Islands at the time of their discovery.

The principal thing in the management of the rookeries will, however, be the limiting of the number of the adult males allowed to enter the rookeries.

Notwithstanding the fact that during recent years a very large proportion of the surplus males has been killed for profit, our annual photographic records show that there has always been, with the exception of one or two seasons, a sufficient surplus of idle males adjacent to each rookery. Such animals force their way in as soon as they acquire the weight and the courage necessary for them to do so. All claims that we have killed too many of the surplus males can easily be disproved by the photographic records of the Bureau of Fisheries.

C. H. Townsend,
Member of the Advisory Board of the Fur Seal Service

BOTANICAL NOTES

FURTHER STUDIES OF THE COCONUT

In a recent paper[1] O. F. Cook publishes the results of his further studies of the coconut. It will be remembered that some years ago he published his first considerable paper on this tree, in which he showed among other things that the name is coconut, as spelled above, and not cocoanut, the dictionary makers to the contrary, notwithstanding. The particular purpose of the present paper appears to be to prove the American origin of this tree, and this the author seems to have done most conclusively. The conclusions may be summarized as follows:

All palms that are related to the coconut (about 200 species, of 20 genera) are American, with possibly one exception. All species of the genus *Cocos* are South American. The most nearly related species are natives of the interior valleys and plateaus of the Andes, where the coconut also thrives, remote from the sea. Neither structure nor habits of the coconut tree indicate that it originated on the seacoast. Moreover, it is not able to maintain itself under littoral conditions without the assistance of man, and is always crowded out by other vegetation after human care is withdrawn.

"The dissemination of the coco palm along tropical coasts is to be ascribed to primitive man." "The theory that it has been disseminated by ocean currents is gratuitous, unproved and improbable." The long-accepted theory as to the essentially littoral habitat of the coconut must be abandoned in favor of one quite the opposite. "The unusually large, heavy seed and the thick, fibrous husk are to be considered as adaptations for protecting the embryo, assisting in germination, and establishing the young plants in the dry climates of interior localities, the only conditions where this palm could be expected to maintain its existence in a wild state."

"PECK'S REPORTS"

Another of the well-known reports of the state botanist of New York came to hand a

[1] Contrib. U. S. National Herbarium, Vol. 14, Pt. 2.

few days ago, adding one more to the long series, now more than forty, that Professor Peck has prepared. One can not help a feeling of admiration for the regularity with which these reports have appeared, each with its contribution of "plants added to the herbarium," "contributors and their contributions," "species not before reported," "new species and varieties," etc. When the writer of this notice was a young college instructor "Peck's Reports" were for him a source of help and inspiration, as he strove laboriously and painfully to know something of the fungus flora of the middle west. Do the young mycologists of to-day prize these New York State Museum reports as much as did those of the 70's and early 80's? The present report contains a monograph of the New York species of the genus *Hypholoma*, and a similar monograph of the genus *Psathyra*. Four good colored plates of the larger fungi are included, two being of edible species.

THE FORESTS OF THE PHILIPPINES

A MOST promising beginning has been made in our knowledge of the forests of the Philippine Islands in the report made by Dr. H. N. Whitford, to the Director of Forestry, Major George P. Ahern, and issued as Bulletin 10 of the Philippine Bureau of Forestry (1911). It consists of two parts, separately printed, as Part I., devoted to Forest Types and Products, and Part II., The Principal Forest Trees, each of about one hundred pages. In his introduction the author says, "The object of this bulletin is to bring together the most important facts concerning the forests of the Philippines and the exploitation of their products." Rough reconnaissance work on a large scale, and rough cruising over large areas, with intensive valuation surveys over certain small selected stands have afforded the data upon which the report is based. The author feels that his results are conservative and fairly reliable.

The family of plants of the greatest importance in its growth of trees is the *Dipterocarpaceae*, and "it is estimated that the dipterocarps include about 144,000,000,000 out of a total of 200,000,000,000 board feet of standing timber in the islands." When we remember that the number of species of trees of all kinds on the islands is placed at about 2,500, the significance of this dominance of the dipterocarps may be appreciated. It is thought that not all of the species of dipterocarps have been described. The trees of many of the species are small, the author citing one case where he collected 80 different species on one acre, and of them but two species attained to "merchantable size."

It is interesting botanically to learn that "more or less ill-defined rings of growth are associated with those species that are wholly or partly deciduous and which are intolerant of shade."

In one paragraph he says "there is little question that practically the entire land area of the Philippines, from sea level to the highest mountains, was originally covered with unbroken forest growth of some kind," and it is estimated that approximately one third of the area is still covered with virgin forests that have never been disturbed. About one sixth of the area has grown up to second-growth forests, making a total of fully one half of the area of the islands in forests. Of the other half probably 10 per cent. of the whole area is under cultivation, the remainder (40 per cent. of the whole) is now in grass lands. These grass lands are kept so by repeated fires which kill all seedlings of woody species, much as occurs upon our own prairies.

Speaking of the dipterocarps the author says that "practically all the species are large trees, reaching heights of 40 to 50 meters, and diameters of 100 to 150 centimeters or more, and it is not rare to find even these dimensions exceeded. They have straight, regular poles, resembling in size and shape the *Liriodendron tulipiferum* (yellow poplar or tulip tree) of the United States."

Many good plates (over 130) and a good map of the islands add greatly to the usefulness of the report. Every botanist who has any interest whatever in forestry will wish to add this report to his library.

PLANT PROTECTION

RECENTLY there came to hand a little book by Sorauer and Rörig under the title "Pflanzenschutz," which should be duplicated in this country. In about 200 pages the authors tell how to recognize and combat various injurious fungi and insects of commonly grown plants. Fifty-eight text figures and seven colored plates add to the usefulness of the book for farmers and non-technical readers. The book was issued by the German Agricultural Society, which is a hint to our similar societies.

SHORT NOTES

AMONG recent small books worthy of note is Geddes and Thompson's "Evolution" (Holt), which presents in about 250 duodecimo pages a summary of the great features of the doctrine of descent. An enumeration of the chapter headings will suffice to give the reader a good idea of the scope of the little book. These are (1) Evidences of Evolution from Explorer and Palaeontologist; (2) Evidences of Evolution from Anatomist, Embryologist and Physiologist; (3) Great Steps in Evolution; (4) Variation and Heredity; (5) Selection; (6) Organism, Function and Environment; (7) Evolution theories in their Social Origins and Inter-Actions; (8) The Evolution Process Once more Reinterpreted; Bibliography.

MRS. FLYNN'S "Flora of Burlington and Vicinity" will interest field botanists of the older type. It includes the names of all the vascular plants in the vicinity of Burlington, Vermont, and is based upon specimens in the herbarium of the University of Vermont. The seventh edition of Gray's Manual is strictly followed in matters of nomenclature. The species admitted are 1,240, of which 962 are strictly native, while 278 are foreign, but "growing without cultivation." While distinctly old-fashioned, and not at all tinctured with any ecological fads, the list will be a handy one for botanists who wish to know what species occur in the area covered.

AMONG recent papers on Philippine botany are C. B. Robinson's monograph of Philippine Urticaceae, which appeared in the December (1910) and February (1911) numbers of the *Philippine Journal of Science.* It covers somewhat more than a hundred pages and includes generic and specific keys, with Latin diagnoses of the new species. The total number of species included is stated to be 129, distributed among 21 genera.

IN the June number of the *Philippine Journal of Science* C. B. Robinson contributes a most interesting paper on "Philippine Hats," dealing primarily with the materials used, and secondarily with their manufacture. The plants used include three ferns (species of *Lygodium*), eight species of *Pandanus,* five species of grasses, two sedges, six or more species of palms, and one species each of *Musaceae, Marantaceae, Orchidaceae, Moraceae, Leguminosae, Sterculiaceae* and two of *Cucurbitaceae.*

IN the same number of the *Journal* E. B. Copeland makes a report upon a collection of Papuan ferns received from Reverend Copland King, of Ambasi, Papua. All told they number 171 species, representing 58 genera. Two new species of *Marattia* are described. The genera with considerable numbers of species are: *Lygodium* (7), *Trichomanes* (11), *Hymenophyllum* (6), *Dryopteris* (16), *Tectaria* (8), *Athyrium* (7), *Asplenium* (12), *Pteris* (7), *Polypodium* (16). Forty-two new species are described, and three new genera, all very properly with Latin diagnoses, in accordance with the Vienna Code.

AFTER a careful study of the testimony Professor Dr. D. H. Campbell concludes (*Am. Nat.*, January, 1911) "that graft-hybrids are possible." He bases his conclusions largely upon the results reached by Professor Winkler of Tubingen. It appears that when two plants of different species are mechanically united, as in grafting, this may result in a "chimaera" (as though two vertical fragments of the different stems with their leaves were united longitudinally), or in a real hybrid arising from a fusion of two somatic

cells derived from the two distinct species. Between these two extremes there are many intermediate forms. The hybrids arising from the fusion of cells behave very much like sexually produced hybrids, even to the number of chromosomes in the hybrid cells.

DR. CAMPBELL's studies of the "Embryo-sac of Pandanus" (*Ann. Bot.*, July, 1911) brings out the fact that at the time of fertilization of the egg there may be present as many as 64 antipodal nuclei, in addition to the usual egg apparatus at the micropylar end. This he regards as a primitive condition, or in other words as an older type of embryo-sac which has survived to the present.

THE new botanical periodical *Zeitschrift für Botanik* (Fischer, Jena), now in its third year, is proving to be a useful addition to the already long list of botanical journals. Its editors are Professors Jost (Strassburg), Oltmanns (Freiburg) and Solms-Laubach (Strassburg). Recent numbers contain papers as follows: "Contributions to our Knowledge of the Laminariaceae" (by Killian), "On the Development of Basidia in Uninucleate Mycelium of *Armillaria mellea*" (Kniep), "On the Reduction-division in the Zygotes of *Spirogyra*, and of the Significance of Synapsis" (Tröndle) in addition to many brief reviews, and classified titles of new literature.

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SPECIAL ARTICLES

PHOSPHORUS METABOLISM DURING EARLY CLEAVAGE OF THE ECHINODERM EGG[1]

IN his recent book on artificial parthenogenesis Professor Loeb[2] assumes that during cleavage of the ovum there is a progressive synthesis of nuclear material from constituents of or reserve substances in the cytoplasm. This assumption is based primarily on the observation of Boveri that following each cell-division there is a growth of the daughter-chromosomes in each resultant cell until their mass is approximately equal in each case to that of the original mother-chromosomes; in other words, the mass of nuclear material increases in a geometric ratio as cleavage progresses. The following observations are also brought forth by Loeb in support of this hypothesis of nuclein synthesis: "Miescher found that the lecithin content of the blood of the salmon was relatively high during spermatogenesis and mentioned the possibility that lecithin might furnish a building material for the nucleinic acid of the spermatozoon head. What is therefore true of the building of nucleinic acid in the spermatozoon is assuredly true also for the building of nucleinic acid in the egg. Hoppe-Seyler has mentioned the fact that all young, quickly growing tissues contain relatively large quantities of lecithin. This is especially true in the case of the ovum. The researches of Kossel have shown, on the other hand, that the yolk of hens' eggs contains no preformed nucleinic acid and the same has been shown to be true for the yolk of silkworms' eggs by Tichomirow. Since there is in the egg after fertilization a rapid synthesis of nuclear material at the expense of certain constituents of the protoplasm or of the yolk, since the latter is rich in lecithin which disappears during nuclein synthesis, it is allowable to suppose that lecithin supplies part of the material for the nucleinic acid."

It may be pointed out that this supposed use of lecithin is not consistent with the idea advanced by Overton,[3] Koch[4] and others that this substance among other lipoids plays an important rôle in the limiting membranes of many animal cells. It would seem indeed that as cleavage progresses more rather than

[1] I am indebted to the Commissioner of Fisheries, Hon. Geo. M. Bowers, for the facilities afforded; and to the director of the Beaufort Laboratory, Mr. H. D. Aller, for many personal courtesies extended to me during this work. Dr. E. P. Lyon has aided me greatly with suggestive criticism.

[2] Loeb, "Die chemische Entwicklungs-erregung des tierischen Eies," p. 18 ff. Berlin, 1909.

[3] Höber, "Physikalische Chemie der Zelle und der Gewebe," p. 114. Leipzig, 1902.

[4] Koch, *Zeit. f. Physiol. Chem.*, B. 63, S. 442. 1909.

less lecithin would be required unless one assumes that this substance functions in more than one way in the cell, which is, of course, quite possible. With these several possibilities open it seemed that some method of experimental attack could be used; that if the idea of nuclein synthesis during cleavage were true it should be possible to show as cell-division progresses a diminution of alcohol-soluble phosphorus with a corresponding increase of phosphorized material not digestible by pepsin.

Using the eggs of *Arbacia punctulata,* the phosphorus partition in the 2–4 cell stage was compared with that in early blastulæ. Two separate experiments are reported. The methods used were the same in each; so the only difference between them was that in Experiment II. a smaller mass of eggs was available —though the latter fertilized and developed a trifle better—than in Experiment I. The details follow.

After removal from the ovaries the eggs were washed several times with large quantities of filtered sea-water until they settled rapidly and left no material suspended in the supernatant liquid. They were then suspended in 2,000 c.c. of sea-water and fertilized with a small amount of sperm. The eggs were stirred and oxygen allowed to bubble through the suspension at short intervals. When the first cleavage occurred 1,000 c.c. were measured off and allowed to settle. The remaining eggs were allowed to divide for five hours from the time of fertilization, reaching then the early blastula stage. These eggs were not allowed to develop to the swimming stage because of the probable difficulty of separating them from the surrounding sea-water without causing cytolysis. 1,000 c.c. were taken and from this point were treated in precisely the same manner as the previous mass of eggs at first cleavage.

In each case—first cleavage and early blastulæ—after settling in sea-water, the latter was drawn off, using a centrifuge to concentrate the eggs as much as possible. It may be added here that previous trials had shown the practical impossibility of separating whole or cytolyzed eggs from the surrounding medium by filtration. Even if by special methods clear filtrates were obtained, the process of filtration was so prolonged that the material decomposed though thymol was added as a preservative. Resort was had, therefore, to a small hand centrifuge, which proved very satisfactory in separating the solid materials from the various liquids. Remarkably clear liquids were obtained in a very short time. During the time that undesirable chemical changes might take place the materials were kept on ice.

The eggs, freed now from sea-water as far as possible, were cytolyzed with successive small portions of distilled water (25–50 c.c.) until the combined filtrates in each case equaled 700 c.c. By this time the pigment was practically entirely removed and it was assumed that all water-soluble material had been taken out. The residual material was then extracted with successive 25 c.c. portions of boiling neutral ethyl alcohol (95 per cent. redistilled over NaOH) until the volume, including two final extractions with boiling absolute alcohol, equalled in each case 400 c.c.

Each of the residues after alcoholic extraction was dried at 60° C. and then digested for four days with 150 c.c. of pepsin-hydrochloric (2 grams of pepsin in 1,000 c.c. of .4 per cent. HCl). The peptic digests were then filtered and washed with cold water.

Phosphorus determinations were now made on (*a*) water-soluble material; (*b*) alcohol-soluble material; (*c*) the filtrates and (*d*) the residues from peptic digestion. Controls were also run on the pepsin solution and on the sperm used in each experiment. The material in each case was digested with 10 c.c. of concentrated sulphuric acid. The digestion was finished by the addition of a few drops of fuming nitric acid. The phosphorus was first precipitated by molybdic acid and weighed finally as magnesium pyrophosphate.[5] The data obtained are tabulated below. The figures represent milligrams of magnesium pyrophosphate.

[5] "Methods of Analysis," Bureau of Chemistry Bulletin 107 (revised), p. 2. 1907.

Material Analyzed	Experiment I.		Experiment II.	
	2-4 Cells	Blastulæ	2-4 Cells	Blastulæ
Water-soluble....	107.5	106.4	66.6	65.4
Alcohol-soluble...	18.1	18.6	11.9	12.3
Peptic filtrate.....	17.6	20.5	14.8	16.7
Peptic residue....	9.3	10.0	8.7	7.4

The results on the filtrates from peptic digestion are corrected in each case for the weight of magnesium pyrophosphate (9.0 mg.) in the pepsin solution used. In neither experiment was there any considerable phosphorus in the sperm used; and it was furthermore assumed that the larger part of the latter remained in the supernatant sea-water after the eggs had settled. It was practically impossible, however, to run control determinations on the supernatant sea-water because the large amount of salts in each case—over 30 grams—made it exceedingly difficult to carry out the preliminary digestion with sulphuric acid.

It will be seen that the relative phosphorus partition runs parallel in the two experiments; that there is not a significant difference in alcohol-soluble (lecithin?) phosphorus or phosphorus in the peptic residues (nuclein?) between the 2–4 cell stage and that of the early blastula. It seems justifiable, therefore, to conclude that *under the present experimental conditions there is during early cleavage of the echinoderm egg no evidence of a chemical synthesis of nuclear material from alcohol-soluble substances in the cytoplasm.*

These results, it is emphasized, are referable only to segmentations in an holoblastic egg prior to the possible ingestion of nuclein-containing food material from the sea-water. As to just what substances aid in the undoubted increase of total mass of morphologic nuclear substance—not to be confused with the specific substance, nuclein, which, as has just been shown, does not increase—as cleavage proceeds, there may here be mentioned only the possibility that the phenomena of streaming cause a morphologic or mechanical aggregate of chromatin-like material originally in the cytoplasm with nuclear chromatin during or following mitosis. A number of investigations on the distributed nucleus, quoted by Professor E. B. Wilson,[6] form an interesting commentary on the possibility just mentioned: "Balbiani, Gruber, Maupas and others have described various Infusoria (*Urostyla, Trachelocerca, Holosticha, Uroleptus*), as well as some rhizopods (*Pelomyxa*), in which the body contains very numerous minute chromatin granules of 'nuclei,' which Gruber showed to multiply by division. Balbiani long since showed that in *Urostyla* these bodies become concentrated toward the center of the cell at the time of division and Bergh demonstrated that they then fuse to form a macro-nucleus of the usual type that elongates, assumes a fibrillar structure and divides by fission. After division of the cell-body the macronucleus again fragments into minute, scattered granules, which in this case certainly represent a distributed nucleus. In the flagellate *Tetramitus* Calkins likewise finds numerous scattered chromatin granules, which at the time of division become aggregated into a single dividing mass; while in other forms the mass (nucleus) persists as such without (*Trachelomonas, Lagenella, Chilomonas*) or with (*Euglena, Synura*) a surrounding membrane."

Of significance also in this connection is Tennent's[7] observation that in eggs of *Arbacia* fertilized with *Moira* sperm when "the daughter nuclei are in the resting condition succeeding the first division, the cytoplasm contains many deeply staining rods. The nucleus at this time does not take the chromatin stain and appears like an empty vesicular structure. In eggs, of the same lot and on the same slides, in which the fibers of the second amphiaster have begun to form, the nucleus again takes the stain and shows the chromatic net, while the cytoplasm is seen to be free from the bodies described."

It seems possible to attack this problem of nuclein synthesis from another angle, namely, by comparing the ratio of purin nitrogen to

[6] Wilson, "The Cell in Development and Inheritance," p. 40. New York, 1902.

[7] Tennent, *Biological Bulletin*, Vol. 15, p. 127. 1908.

total nitrogen in eggs after first cleavage with that at the early blastula stage. Considerable material has been collected for further work along this line.

L. F. SHACKELL

BEAUFORT, N. C.,
September 9, 1911

OBSERVATIONS ON THE INHERITANCE OF CHARACTERS IN ZEA MAYS LINN.[1]

IN "Red Cuzco" and some other breeds of red maize, the red coloring matter is confined to the pericarp; being therefore a fruit character and not a seed character, it does not appear in the ear immediately resulting from a direct cross between a white female and a red male.

In a red dent breed under investigation, the red pigment occurs in the aleurone layer, and not in the pericarp. Being a seed-character, it is transmitted directly by the pollen grain to the ovule of a white breed. It behaves as a dominant to whiteness; where it meets yellowness in the same grain, it is more conspicuous than yellow. The writer has not met with a previous record of the occurrence of a red pigment of this character in the aleurone layer of the maize grain.

When this red dent is crossed with a white sugar breed the segregation, in the second generation, of the two pairs of characters redness *vs.* whiteness and starchiness *vs.* sugariness, is in approximately the following proportions:

$$\text{Red}\begin{cases}\text{starchy} \dots\dots\dots\dots & 56.25\\ \text{sugary} \dots\dots\dots\dots & 18.75\end{cases} = 75\%$$

$$\text{White}\begin{cases}\text{starchy} \dots\dots\dots\dots & 18.75\\ \text{sugary} \dots\dots\dots\dots & 6.25\end{cases} = 25\%$$

In other words:

	Red Grains
Starchy grains	75% of 75% = 56.25%
Sugary grains	25% of 75% = 18.75%
	75.00%

	White Grains
Starchy grains	75% of 25% = 18.75%
Sugary grains	25% of 25% = 6.25%
	25.00%

[1] Fuller details will shortly appear in the *Transactions of the Royal Society of South Africa.*

A single grain has been found on the ear studied, which distinctly shows the starchy character in one half and the sugar character in the other, a very unusual feature.

A study of row-numbers in maize-ears indicates that within certain limits the number of rows of grain on an ear is subject to fluctuating variation, which may perhaps be affected by season or food supply, or both. In more than thirty plants of Arcadia sugar-maize studied this year, each of which produced two ears on one stalk, the uppermost ear has had a different number of rows from that of the lower ear. On thirteen plants the largest number of rows occurred on the lower ear, while on eight plants the largest number was on the upper ear. In twelve plants of two ears the row-numbers were the same on both; in one case there were four more rows on one ear than on the other. Several plants of Hickory King, bearing two ears, have also produced different numbers of rows on the two ears.

The range of variation appears to be limited, however. A normally 8-rowed type ranges between 4 and 14 rows, while a normally 18-rowed type ranges between 12 and 24 rows.

The result of crossing an 8-row with an 18-row type of maize is to produce an intermediate type in the first generation, both 8-row and 18-row types practically disappear in the heterozygous form. The intermediate type bears mostly 10, 12 or 14 rows, the 12-row type greatly predominating. The experiment will be continued next year, to determine the proportion of the 8-row and 18-row types which reappear. The ears produced by the cross and the reciprocal cross are indistinguishable.

A white-cobbed breed crossed with a red-cobbed produces a red cob in the first filial generation, and so does the reciprocal cross.

J. BURTT DAVY

DEPARTMENT OF AGRICULTURE,
PRETORIA

SCIENCE

FRIDAY, NOVEMBER 3, 1911

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

ELECTRICAL ENGINEERS AND THE PUBLIC[1]

MEMBERS of the American Institute of Electrical Engineers are pleased to refer to electrical engineering as a profession, and to the Institute itself as a professional society. When this occurs as a thoughtless repetition of fine-sounding words, it has little meaning, since mere repetition of an alleged truth does not make it a real truth, and it can be established as a real truth only by tracing it to some adequate foundation. But when those statements arise from a ripe understanding that the word profession means more than a mere organized vocation for earning one's bread, it has a high and commendable meaning. The word profession "implies professed attainments in special knowledge, as distinguished from mere skill; a practical dealing with affairs, as distinguished from mere study or investigation; and an application of such knowledge to uses for others, as a vocation, as distinguished from its pursuit for one's own purposes." This sets the professional man in a position which demands from him an attitude of service and of leadership. He must have a masterly knowledge, in addition to skill in a vocation. He must deal practically in the affairs or needs of men. His duties must be performed with a touch of disinterested spirit in addition to the vocational spirit of earning his livelihood. Such men have a duty to the public; and in the performance of that duty they must exert their influence on that thought and practise of the day

[1] President's address of the American Institute of Electrical Engineers, delivered at the annual convention, Chicago, June 27, 1911.

which affects the welfare and progress of the nation. We as electrical engineers can not escape that duty, in case we wish to maintain the professional character of our occupation.

It may be retorted that questions relating to the welfare and progress of the nation are matters of economics and sociology, and not of engineering. The affirmation contained in this retort I will admit, but the negation I deny.

The theory of modern economics is built up under the influences produced by the introduction of steam power, with its potent agencies comprised in the steam railroad, ocean navigation and the use of steam power in industrial operations. These agencies are the creatures of engineers. Watt, Stephenson, Fulton, Ericsson, Boulton, Arkwright, Nasmyth, Bessemer, Siemens, Corliss, Holley and the other fathers of our modern industrial economic conditions were engineers; and it would be folly to deny to the parents an interest in their offspring, and equally folly to assert that the further developments of economic theory are not largely dependent on those industrial changes which are continually produced by the inventive activities of the great body of engineers. When I speak of industrial operations or industrial conditions, it must be understood that I include amongst industrial affairs the great means for transportation and intercommunication which are comprised in railways, telegraphs and telephones, in addition to the manufacture and distribution of products which involve the application of mechanical power as distinguished from animal power, and the manufacture, accompanied by distribution by pipe or wire, of the media for providing illumination and power. The engineers have precipitated these affairs on the world by their inventions; these affairs are in a large measure the support of the engineering profession; and it is the duty of engineers to do their share in molding their various economic creatures so that the creatures may reach the greatest practicable usefulness to society. In fact, it would show a cowardly weakness to suggest that this duty should be avoided by men who are essentially responsible, as the engineers are, for the existing conditions. Theologians and physicians can practise their professions aloof from the ordinary affairs of the world, but the engineers associated with industrial events can not. Moreover, such an avoidance of their duty by the engineers, even if avoidance of responsibility were possible, would be particularly unfortunate in view of the fact that the professed economists and sociologists apparently do not yet hold themselves subject to all the requirements of professional men, but still interpret their duties as being more confined to the field of study and investigation than to applying their knowledge to practical affairs.

It may again be retorted that the tenets which I am advocating will lead engineers out of a professional spirit and into "commercialism." It is worth while to pause here to reflect on that point. The word "commercialism" strictly means the characteristics of business or commercial life, but custom has made it applicable to any undue predominance of commercial ideas in a nation or community, and it has thereby come to infer a willingness to establish the strife for money in a position of precedence over reason and righteousness.

It has been alleged that learning loses of its dignity by becoming fashionable. It has also been alleged that learning loses of its dignity by becoming useful. Of the latter, at least, experience has proved the contrary—happily for engineers who are proud of their profession, for engineering

is necessarily an embodiment of the useful application of knowledge and learning. Engineering, relating, as it does, to the application of the powers of nature to useful purposes, must necessarily bring its followers into intimate contact with commercial affairs in an age when, as in ours, the industries dominate commerce, and the abatement of war has reduced the importance of military engineering. The tenets which I advocate do not tend to entangle the engineers in the depths of "commercialism" with which they may come in contact; but, on the contrary, those tenets propose that engineers should safeguard and nourish their professional spirit by assuming a part in public affairs in a spirit of disinterest, for the purpose of guiding the useful applications of natural forces to the greatest practicable service to society. A true engineer is a devoted follower after truth. He differs diametrically from the devotees of pure "commercialism," who are strictly opportunists. He also differs from pure idealists, who are often notable for refusing to accept any advance unless it wholly meets their personal ideals. The spirit of the engineer rejoices in obtaining any move toward the truth, but is always seeking farther advance. This characteristic spirit has been manifested in men of great achievement in many walks of life. It is a part of the life of such men as Martin Luther, Gladstone and Lincoln.

Those who accept even in part the usual evolutionary doctrines which are summed up by Herbert Spencer in his view that progress occurs by successive differentiations and integrations producing development from the homogeneous to definite, coherent heterogeneity, will assent to the proposition that the modern giant corporation follows in the wake of the one-man business and the simple partnership in response to an inextinguishable natural law. This is a case of natural selection. The progress of corporation development can not be prevented. It is one of the manifestations accompanying improved means of speedy transportation and inter-communication. Of the influence of the latter agencies, a learned and distinguished historian says, "Of all inventions, the alphabet and the printing press alone excepted, those inventions which abridge distance have done most for the civilization of our species. Every improvement of the means of locomotion benefits mankind morally and intellectually as well as materially. . . ." The possibility of, and indeed a necessity for, great corporate organizations came in the train of leading improvements in the means of locomotion and other beneficial inventions which abridge distance and subjugate time. Men of this age do not desire to relinquish the benefits of the improvements. We must, therefore, adjust our mental attitude to dealing properly with the situation; and in making the adjustment we must return to the old and approved recognition that a misdeed is a personal thing, and remember that responsibility for it can not be shifted from the personality of the man in responsibility to an impersonal aggregation entitled a corporation which he manages. In early days when English kings had great prerogatives in the government, and the doctrine of divine right, associated with the doctrine that the king can do no wrong, were still extant, the king was nevertheless limited to an administration of the affairs of the realm conducted, history tells us, in accordance with the laws, and, in case he broke those laws his advisers and agents were held responsible, and they were made personally answerable to the courts. History also indicates that this personal answerability of the advisers and agents had a tremendous influence on the conduct of

government and its relations to the public. In building up our industrial structure we must not overlook the plain guide board of history, and personal answerability must be established. But if we must establish personal answerability to the public, we must also establish fair and generous dealing by the public.

The building up of a great industrial nation in an honorable state of civilization is subject to many hazards—an error may cause injury to the structure that takes years or even decades to eradicate. It is, therefore, desirable to go cautiously and utilize the mature reflection of straight-thinking men who will give their thought to the subject. The forward route is untested, and real progress can be made only by judiciously combining teachings from the records of yesterday with experience of to-day to make a working theory for to-morrow. It has been suggested that a theorist should be defined as a man who thinks he may learn to swim by sitting on the bank and watching a frog. Doubtless, there are many such men in the world, but they are not theorists. The definition is as inaccurate as defining a black object as an object without color. Such men are only inexperienced, superficial or foolish. Theory, as the word is used by engineers, means a working hypothesis founded on all known facts and experience, which may be used to guide progress beyond the margin of past experience. Every successful, progressive man is a constant user of theory in this proper sense of the term. Every progressive step is made according to a theory of the man responsible for the move. Theory is not antagonistic to practise, but is founded on experience and is a guide to progress. Custom should be followed only when it has reason to support it. In the juncture now before us we must utilize the best theories of the corporation relations and the rights of persons and property, and cautiously extend our practises accordingly. No body of men are better equipped for this sound and scientific procedure than a body of professional engineers; and few others are so fully and adequately trained for such procedure as engineers, for the reason that this procedure is in accordance with the every-day steps of their business life. Moreover, the engineers of experience are well adapted to grapple with the mighty problems of a new age, for the reason that an efficient engineer must associate audacity and sobriety in his spirit.

If my premises are tenable, and I believe them to be incontestable, the engineers have a special duty, as professional men who are trained and experienced in straight thinking, to use their influence for the establishment and support of right and reason in the dealings between the public and the public service corporations. The problems surrounding the public service companies in American cities, and their relations to the citizens, should receive particular attention by members of our Institute, for those problems and those relations have been largely brought to their present importance and prominence through the activities of electrical engineers.

The public service corporations are the natural outcome of the demand of the civilized world for efficient and rapid transportation and intercommunication, and the concurrent need as communities become immersed in peaceful industrial pursuits for ample and conveniently provided supplies of water, gas and electric power. They compose a comparatively new and mighty force in the social organism and the organism must be adapted to efficiently utilize this force, but the force must be prevented from dominating or warping the organism. There is no danger of the public service corporations becoming des-

pots as some people seem to fear, provided they are put under proper restraints, but society cannot afford to make restraints which of themselves are unnecessary or unfair. These corporations serve a beneficial end in our life, and their rights are as well founded and should be as well secured and held sacred as the rights of any citizens who are individually or collectively bent on any proper business pursuits.

Some people seem to believe that all public-service corporation men are either wicked or are liars or thieves. This has as little foundation in fact as a belief that all men in Spain carry mandolins or that Spanish women always wear mantillas. If such unjust, superficial and improper opinions are to have influence in this nation, then only misfortune and woe can be the outcome. It is necessary for all men trained in straight thinking to combat such folly and to cry out for fair dealing, one with the other, as between the public-service corporations and the public which they are established to serve. No engineer does his duty who does not stand with fidelity for equally square treatment *for* as *by* these corporations. These corporations are not here as vampires on society, but are here to serve the needs of the people in a reasonable and business-like way; and their proper objects can not be accomplished unless they are treated with reason and established in confidence. They obtain their income from serving the public, and they can not give generous service unless they are granted generous opportunities. When under reasonable restraints and supervision, as by properly constituted public commissions, they are more quickly responsive to public sentiment than could reasonably be expected of any publicly owned business organization of equal magnitude which could exist under our political conditions, and their usefulness is proved beyond contradiction. Perhaps no man is more likely to observe these things than one whose professional practise, like that which has come to me, makes him retained adviser in some instances to public-service companies and in other instances to governments or municipalities, for he has to study fairness to each class of clients in all he does.

A barrier of distrust which exists between these servitors of the people and the people whom they serve is presumably due, on the one hand, to a memory by the public of misdeeds which were perpetrated before recent demands for reform brought about the establishment of adequate public supervision in prominent centers, and to a fear of the repetition of misdeeds where supervision and publicity have not yet been prescribed; and, on the other hand, to a certain reluctance by corporation managers to exhibit full and convincing frankness for fear that such frankness may be made the opportunity by unscrupulous politicians or persons with interested motives to crowd them to the verge of insolvency. These particular conditions of distrust could be obviated by means of the public itself owning the public-service properties and operating them in its own interest, but this is a drastic and undesirable alternative. Any fair-minded man of extended business experience who will study with unbiased intention the details of public ownership and public trading in the venerable and stable cities and states of continental Europe must be impressed with the reality that our inexpert and shifting governmental bodies are wholly unadapted to cope with such responsibilities, or to make an economic success equal on the average to that now accomplished by the privately managed service companies, whether the measure of success be taken on the basis of service provided for a unit of payment or

on any other reasonable basis of comparison.

If the public could feel sure of the ingenuousness of corporation statements and statistics, and the corporations could be protected from unfair attacks made by ignorant, although, in many instances, educated, persons or persons with ulterior motives, the barrier of distrust to which I have referred would be dissipated as dampness is dissipated by the rays of the sun; but this cure requires a long step forward in the average line of progress, for it demands a supervision of the companies which imposes on them exact and ingenuous bookkeeping associated with the presentation to the public of accurate and luminous statements of their business, and it equally demands that the public shall be required to yield justice to the companies with the same ample fullness as individuals seek it for themselves. A progressive step of this nature is always accomplished slowly and hesitatingly. I have observed in Macaulay's writings a paragraph which is graphic in illustration of our present situation. "Everywhere," he says, "there is a class of men who cling with fondness to whatever is ancient, and who, even when convinced by overpowering reasons that innovation would be beneficial, consent to it with many misgivings and forebodings. We find also everywhere another class of men, sanguine in hope, bold in speculation, always pressing forward, quick to discern the imperfections of whatever exists, disposed to think lightly of the risks and inconveniences which attend improvements, and disposed to give every change credit for being an improvement. In the sentiments of both classes there is something to approve. But of both, the best specimens will be found not far from the common frontier. The extreme section of one class consists of bigoted dotards: the extreme section of the other consists of shallow and reckless empirics."

The public, misled or annoyed by the reluctance of some honest but overcautious managements to make frank public statements of financial results and present convincing statistics of operation, enraged by the acts of a few adventurers who from time to time have secured a speculative hold in the public-service field, and enticed by the arguments of individuals with ulterior motives, are likely to follow the radical leadership of demagogues or of honest but false empirics. This is a danger which seriously exists in states where no public supervision of the service companies is provided, and also in a lesser degree in states where such supervision has been established. The danger must be rolled back by the exertions of fair-minded and right-thinking men. A serious menace to the welfare of the nation would be caused if unfair dealing toward the public-service companies were established as a policy. A scrupulously frank and honest dealing with the public by the companies should be insisted on, but the public must be taught the importance of dealing, on its part, with an equally scrupulous fairness and a well-balanced generosity. It is here that I say lies a duty of electrical engineers to the public. It is to give of their time and brain to convincingly establish the facts (the *facts*, I repeat) which the public do not understand in regard to the business of the public-service companies, to indicate the means for rightly treating these new influences which we and our fellow engineers have been creating by our works, and to aid in establishing measures which will favor and sustain mutual confidence and fair dealing between them and the public. This is an obscure and difficult problem on account of its touching the edge of men's ambitions and men's passions, and it seems

at times to possess the opacity and insolubility of a mill-stone; but looking persistently and with care into what appears to be a mill-stone not infrequently proves it to be composed of reasonably transparent material. The members of our institute should take somewhat to themselves as professional men this obscure and difficult problem, and aid in its solution as a matter of their duty to the public.

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY

TWENTY-FIVE YEARS OF OSMOTIC PRESSURE IN THE MEDICAL SCIENCES[1]

ON October 14, 1910, a large number of scientific men met in the lecture room of the Botanical Institute at the University of Utrecht, for the purpose of celebrating the twenty-fifth anniversary of Van't Hoff's theory of "osmotic pressure."[2] Professors Ernst Cohen and Hugo de Vries gave the principal addresses. The former, in his most inspiring and finished address, pointed out the invaluable services rendered by this great master to the science of chemistry.[3] Professor de Vries gave a lecture on vacuoles and on this occasion emphasized the importance of physical chemistry in general and particularly that of the theory of osmotic pressure for plant physiology.[4]

[1] Translated from the German by E. I. Werber, Baltimore, Md.

[2] J. H. Van't Hoff, "Lois de l'equibre chimique dans l'etat dilue, gazez on dissons," *Konglisa Swenska Vetenskaps-Akademiens Handlingar*, 21, No. 17, October 14, 1885.

[3] Ernst Cohen, "Een Kwart eew moderne Chemie," *Chemisch Weekblad*, No. 42, 1910 (Dutch); "Ein Vierteljahrhundert moderner Chemie," *Zeitschrift für Elektrochemie*, B. 16, No. 20, 1910.

[4] Hugo de Vries, "Vacuolen, Verhandl. v. h. Provincial Utrechtsch," *Genootschap van Kunsten en Wetenschappen*, 1910, p. 36.

It would, I venture to say, amount to an unexplainable neglect, if the great body of medical investigators failed to give expression to the strong feeling of gratitude to this great scientist.

It gives me pleasure to present a brief account of the researches of de Vries and Van't Hoff and the indebtedness to them of the sciences referred to in the preceding.

In the first half of the last century it was already known that many substances have the power to attract water and also that this power was of great importance for the life of plants. In 1844, Mitscherlich made the first attempt to determine quantitatively this attraction. His figures, however, as well as those of later investigators, were by no means satisfactory.

As late as 1881 Pfeffer, in his text-book of plant physiology, deplores this fact and points out how important for the study of some of the phenomena of life it would be to know, even if only approximately, the water-attracting force acting in each and every substance contained in a plant cell.

It was in the year following (1882) that Pfeffer's hopes were fully realized by the great botanist Hugo de Vries, who actually solved the problem.[5] He employed three biological methods, of which the *plasmolytic* gave the most reliable results. This method consisted in employing a salt solution strong enough to bring about a slight separation of the contents of the plant cell from the cell membrane, in other words, to induce plasmolysis in the cell. Since this separation of protoplasts (plasmolysis) was due to the fact that the power of the surrounding fluid to attract water was somewhat greater than that of the cell contents, de Vries concluded that solutions of other

[5] Hugo de Vries, Proces-Verbal der Konikl. Akad. von wetenschappen te Amsterdam, October 27, 1882; more exhaustively in *Pringsheims Jahrbücher f. wissensch. Botanik*, 14, 1884, p. 427.

salts causing the same degree of shrinkage when acting upon the same cell, must have a water attracting power of the same degree. DeVries called such solutions, *i. e.*, those having an equal water attracting force, *isotonic solutions;* and the simple relations, which appeared to exist between different concentrations of these solutions, he named the *isotonic coefficients.*

De Vries gave a lecture on these researches in the Amsterdam Academy of Sciences, and luckily had in his audience my late teacher and master, Professor Donders, who, as usually, came back to the laboratory in the afternoon. Donders was in the habit of discussing matters with me whenever a scientific problem attracted his particular interest. It was not, I think, that the great man wanted to hear the opinion of his assistant, but rather the fact that these discussions gave him an opportunity to formulate his thoughts and thus helped him to clarify the problem. Sometimes I could not help thinking that my master went a little too far in his thoughts, but this time everything was clear to me. He spoke about the lecture of de Vries to which he had listened a short while before and the question at once arose whether de Vries's findings for the plant cell would hold true for the animal cell.

I began work at once and it was the red blood corpuscles that I chose as my material. The first step was to find a concentration capable of inducing plasmolysis in these cells. But I failed to find it. No plasmolysis could be observed in my experiments. Then I turned to the study of escape of coloring material from the red blood corpuscles. And in the next year my teacher was able to report on my behalf the results of my investigations before the Amsterdam Academy of Sciences.[6] It was actually found that the red blood corpuscles were also subject to the law of isotonic coefficients. Between the concentrations of salt solutions causing the escape of coloring matter from the blood corpuscles the same numerical relation exists as between the concentrations of salt solutions inducing plasmolysis in the same plant cell. *These researches on the blood corpuscles (1883) marked the beginning of modern physico-chemical research in the medical sciences.*

It was repeatedly stated that Van't Hoff's theory of osmotic pressure laid the foundation for these investigations on the blood corpuscles, but this is decidedly a mistake.

The real basis for this work was given in de Vries's researches in plant physiology. These investigations and my own hæmatological researches furnished important data for an experimental proof of Van't Hoff's theory, which was based principally on thermodynamic considerations and on Pfeffer's findings and which was published for the first time two years later (1885). This historical accuracy, it is hoped, may not be regarded as an underestimation of the importance of Van't Hoff's theory for the medical sciences.

It is true that the physico-chemical researches in the medical sciences do not owe their origin to the influence of Van't Hoff's theory and that these researches were continued with success for almost a decade independently of the theory of osmotic pressure.[7] However, it must be strongly

[6] H. J. Hamburger, Proces-Verbal der Koninkl. Akademie van Wetenschappen te Amsterdam, December 29, 1883. German translation in *Festband der Biochemischen Zeitschrift,* H. J. Hamburger gewidmet zur Feier seiner vor 25 Jahren erfolgten Doktorpromotion, S. 1, 1908. Berlin, Julius Springer.

[7] To these belong among others the first determinations of the water attraction power (osmotic pressure) of the blood serum and other animal fluids by means of the study of the escape of the

emphasized that the influence which this theory exerted on the further development of physico-chemical research in medicine has become one of tremendous value. This will become clear from our further considerations.

But even during the decade referred to this theory exerted considerable influence. For some time after its appearance in its completed form (1887) this theory had a stimulating influence, however latent this may have been. Such terms as "water-attracting force" and "isotonic coefficients" no doubt served well the purpose of successful work, but their meaning was rather puzzling and their explanation by the new theory was received like a revelation. Furthermore, the theory of osmotic pressure with its more exact terminology and concepts helped much in shedding new light on what had been accomplished independently of it in the decade above mentioned.

It may well be asked why it was that relatively many years passed before Van't Hoff's theory came to be recognized in the medical literature. An explanation for this, I think, is given in the fact that the theory met with rather unfavorable criticism among the professional chemists[8] and also from the circumstance that the field of work opened up by the theory of isotonic coefficients was so large and the problems suggested by it so numerous that there actually was no time to take into consideration also the theory of osmotic pressure. Besides, for some time—we may well say, in the first ten years—little interest was shown in these new researches and accordingly the number of workers was very scarce. Indeed we were almost alone in our efforts.

However this may have been, that much at least is quite certain, that the theory of osmotic pressure announced in 1885 would not have achieved such great success, had it not been for *the fact that Van't Hoff was able to utilize Arrhenius's theory of electrolytic dissociation as a supplementary one to his own.*

Not infrequently one finds that there are very unclear and inexact notions about this rather intricate matter. It may, therefore, not be uninteresting to give an account of how it developed, using the original publication as a guide.

What was the actual situation?

According to Van't Hoff the dissolved substance, when in a diluted solution, behaves like a gas. He found that in such solutions the particles of the dissolved substance diffuse in their medium, and in this way exert a pressure on the walls of the dish. If a watery solution is made up in a dish, whose walls are semi-permeable, that is, impermeable to the medium of the

coloring matter from the blood corpuscles (1884) and the investigations on the concept of "physiological salt solutions," on the influence of CO_2, alkali and acids on blood; here belong also the investigations on lymph, resorption, etc.

[8] An illustration to this we may well see in the following incident:

The board of directors of the Deutsche Chemische Gesellschaft had in 1893 invited Van't Hoff to give a lecture on his physico-chemical researches.

In this lecture on January 8, 1894, Van't Hoff is said to have hesitated between two themes and made the following very significant remark: "On the other hand there was the theory of diluted solutions and osmotic pressure, but I preferred to leave the choice to the directors, *because I should not like to speak on a theme which may at present appear rather undesirable on account of the unfavorable criticism at the hands of professional colleagues, which we all highly esteem.* [Italics mine.] However, the directors chose the theory of solutions." (Cf. J. H. Van't Hoff, "Wie die Theorie der Lösungen entstand," *Ber. der Deutschen Chem. Gesellschaft*, XXVII., I., 1894, p. 6.)

This, then, was nine years after Van't Hoff's famous publication in the Swedish academy.

solution, and if this dish is put into water, the dissolved particles, in their futile efforts to diffuse into the surrounding solution, will cause a pressure. This pressure, which is perfectly analogous to the tension of a gas, Van't Hoff called osmotic pressure. According to Van't Hoff every molecule exerts the same pressure; in other words, solutions of an equal molecular concentration have the same osmotic pressure. This was also proved by experiment, *but only for substances belonging to the same category*. The values of osmotic pressure of substances belonging to different categories were compared, and showed considerable differences. *E. g.*, equimolecular solutions of sugar and salt showed an altogether different osmotic pressure. That of the NaCl solution was 1½ times higher than an equimolecular solution of sugar.

This was the situation in 1885, when Van't Hoff published his theory. No wonder, therefore, that the theory could not be generally accepted.

It fell to Arrhenius's theory of electrolytic dissociation to explain away[9] the difficulty contained in Van't Hoff's theory. According to the Swedish investigator the salts in a watery solution, unlike sugar, dissociate partly into ions. To this Van't Hoff added the idea that each ion exerts the same osmotic pressure as would an undissociated molecule.[10] Accordingly the number of particles causing osmotic pressure is much larger in a salt solution than in an equimolecular sugar solution; in the above mentioned case it was 1½ times as large. This explanation removed the obstacles of Van't Hoff's theory and *the isotonic coefficients of de Vries had now a clear meaning.*

It was now obvious that if the coefficients of NaCl and of sugar were 3 and 2, respectively, this was due to the fact that through the partial dissociation of NaCl into the ions Na and Cl, the number of water-attracting particles became 1½ times larger than that of the sugar solution.

It is then not only to de Vries and Van't Hoff, but also to the great Swedish genius, that we owe a heavy debt of gratitude. This *not only because the theory of electrolytic dissociation forms a necessary supplement to Van't Hoff's original theory, but also because it has itself become of tremendous importance to the medical sciences.*

Without exaggeration, I think, we can apply what Wilhelm Ostwald said in this connection about chemistry, to the medical sciences: "Seldom has a lucky thought thrown so much light on so many and so difficult problems"; and in 1890, *i. e.*, three years after the theory of osmotic pressure has been known in its perfect form, Van't Hoff says of the theory of Arrhenius that "it has almost become a fact."

Quite inestimable has been the influence exerted by the de Vries-Van't Hoff-Arrhenius theory on our sciences. There is hardly a chapter in *physiology* that would not bear signs of this influence.

Nowhere has the application of the combined theory of the three great men been so intensive as in the physiology of the blood. This is easy to understand if we consider the fact that the blood corpuscles unlike most of the other cells can be kept

[9] Svante Arrhenius, "Ueber die Dissociation der in Wasser gelösten Stoffe," *Zeitschr. f. Physik. Chemie*, I., 630, 1887. Cf. also, Arrhenius, Behang till Kongl. Svenska Vet. Akad. Handlingaar, 8, No. 13 and 14, 1884.

[10] Van't Hoff, "Die Rolle des osmotischen Druckes in der Analogie zwischen Lösungen und Gasen," *Zeitschr. f. Physik. Chemie*, I., 481, 1887. He says here: ". . . Thus it may appear that to claim Avogadro's law for solutions as forcibly as I have done it here is rather unwarranted. However, my decision in this matter I owe to Arrhenius, who in a letter calls my attention to the probability that in the case of salt solution and the like we have to deal with a dissociation of ions."

isolated and uninjured for a relatively long time. Another advantage offered by the blood corpuscles is that the influence of diverse agents on their volume and form and likeness on their chemical and physico-chemical composition, can be studied with much exactness. Again it is possible, after causing moderate disturbances in the physiological equilibrium, to observe very accurately the exchange of particles between the blood corpuscles and their natural medium, the blood plasma. Furthermore, an excellent object is given in the white blood corpuscles and particularly in the *phagocytes* for the study of the effect of such disturbances on life.

To these researches belongs among others the study of *permeability* of different kinds of cells. This study was begun in 1889 as one of the results of the theory of isotonic coefficients. It was found that the blood corpuscles, despite the fact that their volume remains unchanged in an isotonic salt solution, are permeable to chlorine, if kept in the solution for a sufficiently long time. It is hardly necessary to point out how important the problem of permeability is. The permeability enables the cell to admit some substances into its interior and to refuse admittance to others. In this way the troublesome hypothesis of "conscious selection" of cells between certain substances is replaced by a simple fact of physics. To the pharmacologist this means that remedial agents have to be in a form which would make it easy for them to penetrate the interior of the cell body.

It may well be said that so long as physical and physico-chemical methods are employed in the study of the processes going on in living cells, the problem of permeability will play an important rôle in physiology as well as in pathology and in pharmacology.

Of course it must be expected, and many facts have already proved it, that owing to the high division of labor peculiar to the cells of our organism, the permeability to the same substance will be different with the different kinds of cells. So it is, for instance, a well known fact that the epithelium of the intestine is permeable to many substances, to which the epithelium of the urinary bladder is impermeable.

Another important discovery which we owe to physico-chemical researches was made in studying the formation and resorption of lymph. Attention was called here to *a driving force which must be accurately gauged* and which is based on the fact that a movement of water takes place from a place of low osmotic pressure to nearby places where this pressure is somewhat higher. This driving force is rather common, however, and is for instance always found to play a very important rôle whenever a large protein-molecule breaks up into smaller molecules.

Likewise it is the same driving force which, as Starling has shown, owing to the osmotic pressure of the albumen, is so important in connection with the resorption of fluids in serous cavities.

Of course, in the instances dealt with, the differences in osmotic pressure are low; they correspond to only a few thousandths of a degree of the lowering of the freezing point. However, it would be a mistake to think that this difference in the hydrostatic pressure is without influence to the organism. It must not be forgotten that one thousandth of a degree of the lowering of the freezing point would suffice to bring about a driving force of more than 0.1 m. of water pressure and that this pressure does not differ much from the one causing the flow of blood in the capillaries.

These modern researches were of not less importance, for the development of a new branch of science, namely that of *electro-*

chemistry, founded by Nernst on Arrhenius's theory of ions. It may well be expected that this new field of investigation will throw much light on problems, whenever electric currents are generated in the organism.

It has been but a few years since electrochemistry has found its application in the physiology of muscles and nerves. The automatic action of the heart as well as the electrical currents accompanying it will very likely find a physico-chemical explanation. These are only a few examples from the field of normal physiology.

Let us now see what was the influence of physical chemistry on other medical sciences.

Pathological physiology has gained by important discoveries on the chemical causes of disturbances in the circulation and the genesis of œdema. In *pharmacology* the great achievements in narcotics and disinfection are due in a large measure to physical chemistry.

Bacteriology and *histology* have also profited since by the study of permeability and the law of dissociation the nature of the process of staining came to be understood. We now know why it is that certain kinds of cells absorb some substances while others do not; and we also know why the medium of solution of a stain is of such importance in nuclear and bacterial stains.

Experimental embryology has gained much by a physico-chemical method of artificial parthenogenesis; and as for *practical medicine,* we may say that there is hardly a text-book or a handbook which does not show the influence of the theory of osmotic pressure. This influence may be found even in *surgery.* Examples of this are the intravenous and hypodermic infusion of the so-called physiological salt solutions and local anæsthesia.

We have attempted in the above to show, by few examples only, how great an influence the theory of isotonic coefficients and the closely related but exact theory of osmotic pressure and that of the electrolytic dissociation exerted on the medical sciences.

Also in an *indirect* way this theory proved extremely important. The brilliant results achieved by it in the last few years have been a stimulus for the application of other branches of physical chemistry to biological problems. It was, for instance, the chemistry of colloids and Van't Hoff's theory of chemical equilibrium and process of reaction that were soon taken up and which, making use of the concept of catalysis introduced by Wilhelm Ostwald, may aid us in understanding the mechanism of *enzyme action.*

To those who desire fuller information on what physical chemistry has given us in a short time, and to become familiar with the names of many of its workers I should recommend consulting some works treating exhaustively on this matter.[11]

It may well be asked how it came that physical chemistry had such brilliant results in our sciences. It is, I think, easy to find the answer to this if we only consider the specific methods of this science. These *unlike* the methods of *analytical chemistry* do not involve the use of strong

[11] Ernst Cohen, "Vorträge für Aerzte über Physikalische Chemie," 2. Aufl., 1907, Leipzig, Wilhelm Engelmann; R. Höber, "Physikalische Chemie der Zelle und Gewebe," 2. Aufl., 1906, Leipzig, Wilhelm Engelmann; von Koranyi und Richter, "Physikalische Chemie und Medizin," 2 Bände, 1907–08, Leipzig, Georg Thieme. Several articles in C. Oppenheimer's "Handbuch der Biochemie des Menschen und der Tierre," 1907 ff., Jena, Gustav Fischer; H. J. Hamburger, "Osmotischer Druck und Ionenlehre in den medizinischen Wissenschaften. Zugleich ein Handbuch physikalisch-chemischer Methoden," 3 Bände, 1902–1904, Wiesbaden, J. F. Bergemann.

bases and acids and life-destroying temperatures. On the contrary, the methods of physical chemistry are of such a nature as to make it possible to investigate the complete structure of many unstable substances of the organism, *in statu quo*, without modifying the changeable equilibrium of the often highly complex systems. This will insure to physical chemistry for an unlimited time to come a very important, and, I dare say, together with structural chemistry, a leading place in the medical sciences.

Far be it from me to underestimate the great achievements of other auxiliary sciences and methods of investigation in medical research. However, they can not lead us as far as does chemistry.

Let us, for example, consider the investigation of electric currents initiated by some physiological processes. No one, certainly, would maintain that the registration of these currents is the final aim of their investigation, even if this were done with faultless technique. Rather would not the question be raised, what chemical processes underlie the curves received by registration? Likewise, it is chemistry which we must expect to help us gain a deeper insight into the nature of and laws governing the processes of gland secretion.

Adapting an utterance of Mach, we may say: "The problems of nature resemble a manifoldly knotted thread, the course of which we can follow now from this and then from another loop which attracts our attention." There is no doubt that in future even more than now physical chemistry will furnish us the loop in our effort to disentangle many an intricate problem.

And the names of Hugo de Vries, Van't Hoff and Arrhenius will forever have a place of honor in the history of medical sciences.

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THE COLLEGE MAN IN THE PUBLIC SERVICE

With the growth and development of the higher institutions of learning in the United States, the Federal service is attracting and securing an ever-increasing number of college-trained men. The civil-service act of 1883, providing for the gradual application of the competitive-examination method of selecting public officers and employees, opened the door of opportunity in the executive civil service to those whose merit appears from personal demonstration without reference to political affiliation.

With a better qualified personnel, measuring up to higher standards and guided by nobler ideals, there has been a marked increase in efficiency with greater dignity of service as a natural corollary. This marks the triumph of useful knowledge and discipline acquired in schools and colleges, a reminder that "wisdom is justified of her children" in the time and money spent in the cause of education.

It is hardly necessary to observe that the proper performance of the duties of a large number of employments in the public service does not require collegiate training. The lower grades are generally filled by those who have acquired at least the rudiments of education ordinarily obtained in the public schools, and not a few positions are filled by those who have had the advantages of training in special courses for skilled occupations.

Broadly stated, the largest sphere of usefulness in the public service for the college-trained man is found in the military, administrative, and technical offices of the executive branch of the federal government, as well as in legislative and judicial offices.

Positions in the military service, being filled principally by graduates of the government collegiate institutions at West Point and Annapolis, offer careers to comparatively few graduates of other schools. However, there are opportunities for appointment to some places in the military and naval services through competitive examinations held by the respective departments. Among these may be

mentioned positions in the medical corps of the army and of the navy, civil engineers in the engineer corps of the army, assistant naval constructors in the navy, second lieutenants in the army and in the marine corps. The war department has at the present time about one hundred and fifty vacancies in the cavalry, field artillery, and infantry branches of the army that are to be filled from civil life after preference has been given to enlisted men capable of passing the tests required for promotion from the ranks. To secure nomination for a commission in the army a civilian must pass (1) a preliminary mental examination, (2) a physical test, and (3) a final mental examination. Graduates of "recognized" colleges or universities or of institutions of learning at which officers of the army are detailed as professors of military science and tactics of a certain standard, are not required to take the preliminary mental test, and upon passing the physical test and the final mental examination "honor" graduates of such institutions receive preference in appointment. An examination is now in course of preparation by the war department to fill from civil life ten places of civil engineer in the engineer corps of the army. The United States Public Health and Marine Hospital Service offers a career to graduates in medicine who can pass the examination prescribed by the service. The diplomatic and consular services have recently been placed, by act of congress and executive order, on a higher plane and made more permanent in character. Entrance to either service is through examination, and vacancies in the more important posts are filled by those who demonstrate ability in the lower-salaried offices. The entrance examination is searching and includes collegiate work. All appointees to these positions in the various services mentioned are commissioned by the President of the United States.

Public confidence in the worth of college training is seen in the choice, through the elective franchise, of members of congress, of whom nearly one half are college graduates. What was said upon this subject some years ago by Dr. Garfield, then of Princeton University, can be said with even greater truth to-day: "The educated man has no better claim on the suffrages of the people than the uneducated, so long as there are both trained and untrained bodies of men in the community, for this is government by the people; but the educated man, exercising his power as a creator of sound public opinion, occupies a position from which he can not be driven by the machinations of the politician and to which men of purely practical political experience can not be appointed or elected." It is scarcely necessary to add that a majority of the justices and judges in the federal judiciary are men of collegiate training.

Owing to the number and variety of administrative and technical offices in the executive branch of the public service, the university-trained man has a wide field for selection, and the high degree of ability or technical training required offers careers in the civil service often more purely professional and not less dignified or useful, even though sometimes inadequately compensated, than a legislative, judicial or military career.

With respect to administrative officers, including secretaries and assistant secretaries of departments, commissioners, heads of bureaus, and other subordinate officers, men with college training are usually selected for appointment. Promotion of meritorious subordinate officials to administrative offices is not by any means so rare nowadays as it was in former years. There are hundreds of civil administrative officials who, having entered the service in subordinate capacities and demonstrated their ability, have been advanced to more responsible positions on their record. The recognition of merit creates a healthy ambition on the part of subordinates to excel in the performance of their duties and thus to win promotion.

It is in the field of applied science, however, that the demand for university training is imperative and where the personnel of the service is almost wholly composed of college men. Washington is not only the seat of government but also the abode of learning,

especially that learning which is acquired by research and original investigation. Of two thousand leading scientific men mentioned in "American Men of Science," by Professor Cattell, two hundred and twenty, or eleven per cent., reside in Washington, a percentage exceeded only in the states of Massachusetts and New York. President Jordan, of Stanford University, himself formerly engaged by the United States for scientific work, in an article on the establishment of a national university, says: "The scholars and investigators now maintained at Washington exert an influence far beyond that of their official position." A very large body of university-trained men in Washington are devoting themselves to study and experimentation, endeavoring to gain concrete knowledge that may be applied to the development of the country's resources. A writer in *The Outlook* of July 24, 1909, upon the subject, "Patriots in the Public Service," paid a graceful and well deserved tribute to the ability and patriotic devotion of the scientists who labor in the federal service. "There is no class of men," he says, "who contribute so directly and on so large a scale to the welfare, progress and wealth of the whole people as do the scientists of the federal government. This is due to their exceptional ability, to their *esprit de corps,* the watchword of which is disinterested service, and to the position of vantage and influence which their official status gives them."

Governmental activity along lines of applied science has reached huge proportions. Thousands of scientists, scores of laboratories and an annual expenditure of a hundred million dollars but inadequately express the magnitude of governmental enterprise in this direction. The current appropriations for the Department of Agriculture alone are over twenty millions of dollars, and investigation is going on in every field where systematized knowledge can aid in the conservation of resources, in the multiplication of products, or in the solution of economic problems of the rural community.

Some of the activities of bureaus of the Department of Agriculture are indicated in the following:[1]

Weather Bureau: meteorology.

Bureau of Animal Industry: pathology, zoology, biochemistry.

Bureau of Plant Industry: plant physiology and pathology, pomology, horticulture.

Forest Service: dendrology, silviculture, utilization of wood products.

Bureau of Chemistry: investigations and analyses of fertilizers, agricultural products, foods, drugs, etc.

Bureau of Soils: analytic, fertility and soil-water investigations.

Bureau of Entomology.

Bureau of Biological Survey.

Office of Experiment Stations: nutrition, irrigation and drainage investigations.

Office of Public Roads: chemistry, petrography, scientific road construction.

Among the bureaus and offices of other departments engaging in work of a scientific or technical character are:[1]

Treasury Department:

Public Health and Marine-Hospital Service, with its Hygienic Laboratory: medicine and surgery, chemistry, pharmacology, zoology, sanitation.

Supervising Architect's Office: employing architects, civil engineers, etc.

Bureau of the Mint: coining and assaying, involving chemistry, metallurgy, etc.

Navy Department:

Naval Observatory: astronomy and mathematics.

Hydrographic Office: hydrography and cartography.

Interior Department:

Geological Survey: geology, paleontology, chemistry.

Bureau of Mines: physics, chemistry, mining, metallurgy.

Patent Office: investigations in almost every branch of applied science.

Reclamation Service: civil engineering.

Government Hospital for the Insane: mental diseases.

[1] This abridged reference to bureaus and offices and their activities is merely suggestive and is not intended to be a complete or detailed enumeration of all bureaus and offices doing scientific or technical work, of their functions or of the sciences involved.

Department of Commerce and Labor:

Bureau of Standards: physical and chemical investigations.

Coast and Geodetic Survey: geodesy.

Bureau of Fisheries: aquatic biology and physics, oceanography, applied ichthyology, utilization of water products.

Bureaus of the Census, of Statistics and of Labor: statistics, social and economic subjects.

Lighthouse Service: civil engineering.

Smithsonian Institution and National Museum: natural sciences.

Several bureaus of the different departments are engaged in technical work involving civil, electrical and mechanical engineering.

The headquarters at Washington serve as a training school in some of the bureaus which have field services. Employees are trained in the central office before being sent out to field stations. In other bureaus employees gather material in the field during the summer months and in the winter return to Washington to prepare the material for study and publication.

If salaries of scientists and experts in the public service are in general somewhat inadequate considering the education required and the scholastic nature of the duties involved, there are compensatory advantages which must not be overlooked in comparing a career in the public service with a career in private life. The government is liberal in furnishing adequate equipment in the way of laboratories and libraries to carry on its research work. Notable libraries and laboratories are the Libraries of Congress, the Department of Agriculture, the Bureau of Education and the Surgeon General's Office in the War Department; the law libraries of the Supreme Court and the Department of Justice; the laboratories of the Bureau of Standards, the Department of Agriculture, the Bureau of Mines and the Hygienic Laboratory and the laboratory of the Army Medical Museum.

While men of exceptional attainments in special lines, employed as collaborators and experts, are often given a monetary compensation far below what they might receive in private employment, they gain the prestige following their selection by the government as recognized authorities, and, also, the opportunity to follow out, with ample assistance and equipment, various lines of investigation of great ultimate benefit to the people. Young college men, with the capacity for original work, and with a thorough foundation of theoretical knowledge, find encouragement to pursue the practical side of science.

Industrial organizations demand men trained in applied science. The government service not only offers opportunity for advancement, but is also used by private employers of technical skill as a hunting ground and source of supply. Many opportunities are given experts in the different bureaus to enter university or commercial positions, often at salaries more than double their government compensation. In consequence, resignations from the higher offices are comparatively frequent, promotions follow, and the resulting vacancy in the lowest grade is filled by appointment through competitive examination.

Many clubs and associations furnish opportunities for the exchange and diffusion of ideas. The Cosmos Club, the National Geographic Society, and the Washington Academy of Sciences may be mentioned as examples, and many branches of science have their corresponding societies. The Carnegie Institution for research, though a private foundation, has given additional importance to Washington as a center of learning. With so large a number of eminent scientists working under favorable conditions and the stimulation derived from social intercourse and exchange of thought, an unusual environment and atmosphere, at once healthful and helpful, are created and sustained.

The college man in the public service is today essential to the maintenance of efficient and economical administration, and he should enter it with as much assurance of an honorable career as do the British who enter their home or foreign services. The college man's training has been systematic; he has been taught to recognize fundamental principles; he has learned to reason, to coordinate, to concentrate all of his powers upon the subject in question. When he enters the service

his education is still incomplete, but he brings with him an ordered mind which makes easier his own path and that of his superiors, for he is quick to grasp essentials and to reach results. He outstrips his less favored brother who lacks the training and discipline of the college or university; and the fact that occasionally there are to be met splendid examples of practical intelligence and energy whose training has been obtained in the world's hard school of experience and not within academic walls does not in the least lessen the force of the contention in favor of the college-trained man's availability.

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CONCERNING BOTANICAL INVESTIGATION IN COLLEGES

DURING the last two or three years several articles have appeared in SCIENCE which have had to do wholly or in part with scientific investigation in colleges. As a college teacher the writer has read these with interest. He is just entering upon his twentieth year as a college teacher and has, during two decades of experience with college students, reached certain conclusions concerning this subject, especially in so far as it relates to his own subject—botany. It is not believed that botanical science differs greatly from other sciences with respect to investigation, but it has seemed best to the writer to confine his statements to the science which he is teaching.

Every teacher of botany should be an investigator. The spirit of investigation, which appears in the normal person in early childhood, should never be stifled in one who is to teach botany or who is teaching that science. When the teacher of botany ceases to be an investigator he should retire. His investigation should extend at least to the plant life about him and to the literature directly or indirectly relating to his teaching. Some botanists fear that this spirit of investigation will, if carried further, interfere with teaching in college. The writer pleads guilty of seeing 100,000 titles in a single year in search of matter that might aid in his teaching and in the advancement of botanical science, recording some titles for future use, and examining others minutely. At the same time he was carrying forward some laboratory in-

vestigation; and he was conscious every time he came back to the classroom from his private laboratory or from the library that he was better fitted for his work and had a keener relish for it. For some teachers investigation is as much a tonic as is a pleasure trip or the round of social enjoyment for others.

Whether the teacher's investigation should extend far beyond the field of his teaching is a question for each one to consider for himself. Certainly the college teacher of botany may well include in his investigation many things which will probably never be used in the classroom, but which round out his knowledge of his subject, make him a better teacher, and may be drawn upon if needed. But his investigation should be secondary to his teaching and should be closely enough connected with it, at least in its initial stages, so that some of the facts ascertained may bear directly on the teaching. But if he be an investigator in the best sense, he will eventually push his investigation to the limits of human knowledge in some direction. His investigation now becomes real research. The question now is whether he shall continue or stop. He certainly should do the latter if he does not regard his research of considerable human interest and if his enthusiasm for such isolated investigation does not make it a pleasure rather than a burden for part of his spare hours. If he has this faith in the value of his work and his enthusiasm inspires him to continue, the institution for which he works can afford to lighten his burden somewhat, if possible, for the benefit that such example will have on other teachers and on students in encouraging them to scholarly attainment. Some kinds of research can be carried forward on two or three hours' work each day; and the teacher can easily learn to drop his research and go to his students refreshed and the more ready to work with them because of the keen mental gymnastics connected with his own laborious study, the teaching by its different and disconnected nature seeming like a diversion. The man of strong body and active mind can carry the investigation forward and still keep abreast his profession as a teacher.

The teaching being of prime importance, the college teacher's botanical investigation should never be required to be done at a given time, and he should be free to drop it for a day, a week or a month whenever his teaching requires all of his time. Teaching is an aid to research, and research is an aid to teaching; and there are lines of research that touch college teaching as well as university teaching. The university teacher may make research his main work; the college teacher should never. No college teacher should be chosen or retained mainly on account of his ability as an investigator, but encouraging a college teacher in a limited amount of research is a different matter. No science stimulates to investigation and research more than botany, and the college teacher of this science who is not an investigator is scarcely worthy of the profession.

But what of botanical investigation by the college student? No college student should be thrown on his own resources in investigation to the exclusion of regular instruction after two or three years of botanical study. The student is too narrow at this time and will remain so if he begins to give much of his time to investigation. But the writer believes that some young people should begin specialization in the late teens and that in rare instances a part of this specialization may well be investigation, even for the undergraduate student. And why not? We often start the child at music as early as five or six years, but we too commonly attempt to thwart the desire of the youth for investigation until the last bit of enthusiasm and initiative is crushed. Some would smother it in the brightest and best prepared undergraduate and expect it to burst into a living flame soon after the student reaches the university. The rare undergraduate who has the desire, ability and time for investigation of some definite botanical problem and who has a teacher who can not or will not encourage and direct him is unfortunate. It is a misfortune that some college teachers of botany are not investiga-

tors and can not direct such students. On the other hand, it is fortunate for the college teacher that very few of the students in our classes are ready to attempt special problems.

Even after many years of experience, the writer does not think that he should attempt to direct more than two or three of his students in special investigation at one time. These he tries to select early in the courses in botany and to suggest something to them which may be carried along for a time with their regular work and take more of their time as they advance, the investigation sometimes being finished under his direction after they have graduated. Every advanced student of botany might well be expected to do seminar work, but few teachers can find time to direct all advanced students properly even in this. The writer has a senior college student who has been working on a special problem for two years and who spent the whole of last summer in laboratory investigation and library work, in matter related to this problem and others similar to it, without credit on his course. This student has gone through about 40,000 titles in search of literature pertaining to this work and is aiding his teacher in perfecting his lectures on the subject, and in putting them together in systematic fashion. The student is by no means narrow in his botanical training, nor is he regarded narrow as a college student.

Independence and originality should be encouraged, and why should we discourage the exceptional student when he reaches the point where he wants to attempt some independent work? The effort may or may not result in something worth publishing, and if published, it should not be tabooed because done by an undergraduate student. Some of the best research is done by those who have had no college or university work. So far as they go, the results obtained by undergraduates are sometimes equal to those of graduate students who undertake more difficult problems. Like the teacher's research, the student's investigation should center about some problem related to his undergraduate courses and his proposed life work. There are many problems of this kind. Some of them are work on some portion of a local or a state flora, investigation of some plant disease, the study of the woodlots of a small area adjacent to the college, the working out of keys for the identification of certain fungi or other plants of the region, the investigation of botanical instruction in high schools or colleges, studies in laboratory administration, etc. These and many other problems may well be attempted by the exceptional undergraduate, provided his teacher has sufficient insight and enthusiasm to aid him when he needs help.

Lest the drift of the argument above may have obscured the writer's views somewhat, it needs to be repeated in closing that the investigation of the undergraduate should never exclude thorough and broad botanical training, nor should it replace a knowledge of the elements of many subjects in the college curriculum. Hence it must be confined to the rare student, who is especially fitted and has time for this work and the more important general work which will give him a broad mental training.

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THE "KAISER-WILHELM INSTITUT FUR PHYSIKALISCHE CHEMIE UND ELEKTROCHEMIE"

ON October 1 Professor F. Haber will begin his work as director of the new Kaiser-Wilhelm Institut für physikalische Chemie und Elektrochemie at Dahlem near Berlin. The buildings of the Institut, work upon which was begun during the present summer, are being erected by the Prussian government working in conjunction with the "Koppel-Stiftung for the purpose of improving the intellectual relations of Germany with other lands."

The "Koppel-Stiftung" which was founded in Berlin some years ago by Geheimer Kommerzienrat Leopold Koppel, and which until now has maintained the German School of Medicine in Shanghai and the American Institute in Berlin, will provide the funds for

the erection of the new institute and will also give thirty-five thousand Marks annually for its maintenance during a period of ten years. The Prussian government has provided the site which is situated at the terminus of the new underground railway from the center of Berlin to Dahlem, and has endowed the institute with the sum of fifty thousand Marks annually.

The institute will be controlled by a board consisting of two representatives of the German government, two representatives of the Koppel-Stiftung and the director of the institute. The director has an absolutely free hand in the choice of his work, his fellow workers and his assistants. For the admission of investigators who wish to follow their own lines of investigation in the institute with their own means, the director must have the assent of the board of control.

The institute will consist of scientific and technical departments in separate buildings. The building of the scientific department is 600 square meters in ground area, and has a basement entirely underground, containing constant temperature rooms. On the ground floor are the professor's laboratory and consulting room, the offices, the calibrating room in which are to be kept the necessary laboratory standards, the mechanic's workshop and a lecture theater to seat twenty-five persons. Further lecture rooms are not provided in the building as *teaching in the ordinary sense is not contemplated in the institute.* The first floor will be devoted to the library, chief assistant's room, glass blowing room and a laboratory for eight research men. On the second floor are the living rooms for the mechanic and his family, since the mechanic also acts as caretaker. This floor also contains rooms for photo-chemistry, for scientific collections and work places for several more research workers.

The building is connected by a corridor with the technical department, whose most important feature is the machinery hall with a floor space of two hundred square meters. This hall is surrounded by smaller rooms for chemical preparations, high voltage and heavy current work and a blacksmith shop. The ground floor of the technical building contains a consultation room and the laboratory of the assistant in charge of that department. On the first floor are the living accommodations for two assistants and an engine-man and also a room for the serving of refreshments.

The director's house will be erected in the grounds of the institute.

Although there exists no stipulation on the point, *it may be taken as a rule that, on account of the fact that no teaching as such is to be undertaken, only such students will be admitted by the director as have already finished their normal university course and desire a wider experience in scientific research.* This will mean that students who come directly from American universities should have the degree of doctor of philosophy in chemistry, or physics, or an equivalent training. There are no restrictions whatever as to the nationality of the men admitted by the director.

The director of the institute, Professor Haber, was born in Breslau in 1868, and obtained his Ph.D. in Berlin in 1891. After obtaining his degree he spent several years, partly in technical work and partly in securing further scientific training. In 1894 he went to Karlsruhe and was appointed privat-dozent in chemical technology in 1896 and ausserordentlicher professor in 1898. In 1902 he was sent to America by the Bunsen Society of Applied Physical Chemistry to study the system of chemical instruction and the condition of electrochemical industries in the United States. In 1906 he was appointed to the post of ordentlicher professor in physical and electrochemistry in Karlsruhe, where he built up the best equipped research laboratory of physical chemistry in the world. Students from all parts of the world were attracted to this laboratory to such an extent that its accommodations were insufficient to allow all of them to enter, even although Professor Haber admitted as many as forty men at one time as research workers. What was most remarkable was that he personally directed the work of all of these men, and often aided them in their experimental work. In 1907 he was called to

take the place of Lunge in Zurich as professor of chemical technology and in 1909 he was asked to undertake the control of one of the largest chemical works in Germany, but he declined both of these appointments.

Professor Haber introduced into Germany the rational method of instruction in elementary chemistry as embodied in the laboratory outline written by Alexander Smith. This book was translated into German by Professor Haber and Fritz Hiller. The two books: 1898, "Lehrbuch der technischen Elektrochemie auf wissenschaftlicher Grundlage" (now out of print); 1905, "Thermodynamik technischer Gasreaktionen" (English edition, 1908), together with numerous contributions to the *Zeitschrift für Elektrochemie, Wiedemann's Annalen* and the *Zeitschrift für physikalische Chemie,* constitute his literary activities.

One of Professor Haber's most important researches was that upon the ammonia gas equilibrium at high temperatures. This work resulted in the development of a commercial method for the manufacture of pure ammonia directly from the elements by the use of osmium or uranium as a catalyzer. Another important series of researches was that upon the properties of flames, including the gas equilibria involved, the ionization and conductivity of the gases and the action of the ions as catalyzers. He has spent much time during the last few years upon the study of the escape of electrons from the reacting surfaces of metals and the effects of electrons upon gas equilibria and upon the velocity of chemical reactions. His other recent researches have been mostly upon the following subjects: the electromotive force of the oxyhydrogen cell at high temperatures; the oxidation of nitrogen in the high potential arc; a gas refractometer for the optical analysis of gases, according to Rayleigh's principle; electrical forces at phase boundaries; the corrosion of iron by stray currents from street railways; the reduction of hydroxylamine; the use of solid materials such as glass and porcelain as electrolytes; the equilibrium between magnesium chloride and oxygen; electrode potentials and electrolytic reduction; the laboratory preparation of aluminium; the preparation of hydrogen peroxide by electrolysis; experiments on the decompositions and combustion of the hydrocarbons, and autoxidation.

The writer wishes to thank Dr. Fritz Hiller, of Berlin, for the greater part of the information contained in this article. The statements in regard to the purposes and government of the institute are official.

WILLIAM D. HARKINS
UNIVERSITY OF MONTANA,
September 30, 1911

THE GENERAL EDUCATION BOARD

CONDITIONAL appropriations aggregating \$635,000 have been granted to six colleges and universities by the board of trustees of the General Education Board. Applications from twenty-four institutions were presented. From this list the board selected six among which is distributed conditionally the available funds as follows:

To Bucknell University, Lewisburg, Pa., \$35,000 towards \$160,000; to Earlham College, Richmond, Ind., \$75,000 towards \$400,000; to Furman University, Greenville, S. C., \$25,000 towards \$100,000; to Grinnell College, Grinnell, Ia., \$100,000 towards \$500,000; to Smith College, \$200,000 towards \$1,000,000; to Southern Methodist University, Dallas, Tex., \$200,000 towards \$1,000,000.

During the meeting attention was called to the fact that since Mr. Rockefeller made his first contribution to the board for the promotion of higher education, contributions have been made to ninety-one institutions in an aggregate amount of \$7,625,000 towards a total of \$35,909,512. Fifty-one institutions to which the board has made conditional contributions have completed the subscriptions for the supplemental sums required and to these institutions the board has already paid \$3,500,000 in cash. It was pointed out that as a result of the campaigns made by these fifty-one institutions their assets have been increased by over \$19,000,000. Their student bodies have increased by 2,047, 183 new professors have

been employed and the annual payment to professors in these fifty-one institutions has been increased $421,712.

A further statement by the board showed that it is now paying the salary and traveling expenses at twelve of the state universities of the southern states of professors of secondary education engaged in promoting the establishment of public high schools. Since the beginning of this work, five years ago, 912 new public high schools have been established in the southern states; 824 teachers have been added to the schools which were already in existence, 656 new public high school buildings have been constructed at a cost of $9,000,000, and the funds for the annual support of high schools have been increased by $1,688,894.

The board has contributed between $600,000 and $700,000 to forty-one schools for negroes.

The board's statement calls attention to its work in helping to fight the boll weevil by farm demonstration in southern states. It has contributed $400,000 for this purpose. The Department of Agriculture took over the work in some of the states so that the work of the general education board is now limited to Maryland, Virginia, North Carolina, South Carolina and Georgia. The salaries and expenses of 219 agents are paid by the board. These men are conducting demonstrations on 20,000 farms. They have also organized boys' corn clubs with a present membership of 50,000 and girls' canning and poultry clubs with a rapidly growing membership.

SCIENTIFIC NOTES AND NEWS

Dr. W. H. Emmons, of the University of Chicago, has been elected director of the Minnesota State Geological Survey, as well as professor in the university.

Professor J. G. Lipman has been made director of the experiment station and of the college farm at Rutgers College.

Rev. Joel H. Metcalf has moved his observatory to Winchester, Mass., eight miles from Boston, where he expects to renew his work of photographing asteroids.

Dr. Richard Dedekind, professor of mathematics in the Technical School at Brunswick, has celebrated his eightieth birthday.

At the Lister Institute Drs. E. E. Atkin and W. Ray have been appointed to be assistant bacteriologists, Mr. A. W. Bacot to be entomologist and Dr. Casimir Funk to be a research scholar.

Professor R. H. Tucker, astronomer at the Lick Observatory, has returned to Mt. Hamilton after three years leave of absence. He has been in charge of the astronomical expedition to Argentina, under the auspices of the Carnegie Institution.

Dr. and Mrs. Charles W. Eliot intend to sail from this country on November 7 on a trip around the world to last about eight months.

Dr. R. R. Gates expects to sail for Europe on November 3, to carry on investigations during the winter in the botanical laboratories at the Royal College of Science, London.

A complimentary dinner was given on October 26 by the instructing staff of the Massachusetts Institute of Technology to meet the three professors who have retired this year from active work at the institute. These are Gaetano Lanza, professor of theoretical and applied mechanics; Peter Schwamb, professor of machine design, and Francis W. Chandler, professor of architecture.

Dr. N. C. Ricker, professor of architecture, and Professor I. O. Baker, in charge of the department of civil engineering of the University of Illinois, have been appointed by Governor Deneen as members of the commission to revise and codify the building laws of the state of Illinois, which commission was authorized by the last general assembly of the state. The other members of the commission are Mr. R. E. Schmidt, Mr. W. C. Armstrong and Mr. W. S. Stahl, of Chicago; Mr. W. H. Merrill, of Lake Forest, and Mr. G. J. Jobst, of Peoria. Dr. Ricker is chairman of the commission.

Dean C. B. Connelley, of the School of Applied Industries of the Carnegie Technical Schools, has been appointed a member of the

new Pittsburgh Board of Public Education, which, under the new school code of the state, assumes control of the educational system of the city on November 13.

THE "Rôle of the Salts in the Preservation of Life" was the subject of the Wesley M. Carpenter lecture, delivered at the New York Academy of Medicine on October 19, by Jacques Loeb, M.D., Ph.D., Sc.D., of the Rockefeller Institute.

ETHER day was observed October 16 at the Massachusetts General Hospital in Boston by the usual clinics and luncheon. In the afternoon Dr. Simon Flexner gave an address on "The Biologic Basis of Specific Therapy." The alumni met for a banquet in the evening and were addressed by Drs. Simon Flexner, New York City; Charles F. Stokes, Surgeon-General U. S. Army, and Harvey Cushing, Baltimore, who is to be in charge of the surgical side of the new Peter Bent Brigham Hospital, now in process of construction.

A COURSE of six lectures will be given by Professor Franz Cumont, of Brussels, on "Astrology and Religion," at the University of Pennsylvania at 4 P.M. on the following days:

Monday, October 30—The Chaldeans.

Thursday, November 2—Babylonia and Greece.

Monday, November 6—Dissemination of Astrology in the West.

Thursday, November 9—Astral Theology.

Monday, November 13—Astral Mysticism; Ethics and Cult.

Thursday, November 16—Astral Doctrine of the Future Life.

THE twenty-ninth annual congress of the American Ornithologists' Union will convene in Philadelphia, on November 13, at 8 P.M. The evening session will be devoted to the election of officers and the transaction of other routine business. The meetings, which are open to the public and devoted to the reading and discussion of scientific papers, will be held in the lecture hall of the Academy of Natural Sciences, 19th and Race Sts. (Logan Square), commencing on Tuesday, November 14, and continuing for three days. Information regarding the congress can be had by addressing the secretary, Mr. John H. Sage, Portland, Conn.

THE British government is sending out a further commission to central Africa in connection with sleeping sickness. This will be in charge of Colonel Sir David Bruce, who will be accompanied by Lady Bruce and assisted by Captain Hamerton, R.A.M.C., Professor Newstead, of the Liverpool School of Tropical Medicine, Major Harvey, R.A.M.C., Staff Sergeant Gibbons and Mr. James Wilson. The work of the commission will on this occasion be confined to Nyasaland, where over 40 cases of sleeping sickness have occurred since 1909. The commission, which is also under the auspices of the Royal Society, is expected to be absent from England for three years. Sir David and Lady Bruce and the other members will leave Marseilles on November 10, and will proceed up the Zambesi and the Shire rivers to Blantyre and Zomba, the capital of Nyasaland.

THE London *Times* states that Mme. Curie has asked M. Nenot, the architect of the "Radium Palace," which is being built on the site of a former convent in the Rue Saint Jacques, to add to it a laboratory for purposes of instruction. M. Nenot, who is official architect to the Sorbonne, has replied that the additional building would entail an expenditure of £1,600, and that he will ask the University of Paris to authorize its construction.

LECTURES before the Royal Geographical Society will be given as follows:

November 6—The Norsemen in America, by Dr. Fridtjof Nansen.

November 20—Volcanic Craters and Explosions, by Dr. Tempest Anderson.

December 4—The Geography and Economic Development of British Central Africa, by Sir Alfred Sharpe.

December 18—American Deserts, by Dr. T. McDougal.

AT the occasion of the two hundredth anniversary of M. V. Lomonosov, the Academy of Sciences of St. Petersburg founded the "Lomonosov Institute" for investigations in physics, chemistry and geology. A building

site has been provided by the city of St. Petersburg.

Professor Florentino Ameghino, the well-known paleontologist and director of the Museo Nacional in Buenos Aires, died on August 6 at La Plata, at the age of fifty-six years.

Dr. Joseph Bell, a distinguished Edinburgh surgeon, has died at the age of seventy-four years.

M. Louis-Joseph Troost, the eminent French chemist, has died, aged eighty-five years.

A monument to Michael Servetus was unveiled at Vienne in Dauphiné, where he resided as the medical attendant of the Archbishop Paul Paulmier from 1541 to 1553. According to the London *Times* the monument represents the burning of Servetus at the stake (October 27, 1553). He stands in the midst of the faggots chained to a stone with his book of theological tracts tied to his girdle. On his head is a wreath of leaves covered with brimstone. The representative of the University of Paris, Professor Charles Richet, spoke of the discovery by Servetus of the pulmonary circulation of the blood as marvellous and as *prolem sine matre creatam* since Servetus, unlike Harvey, had not practised vivisection, nor had he proceeded by a complete inductive study of anatomy. His contemporaries could not appreciate his discovery; it was not immediately followed up, and seventy-five years elapsed before it was scientifically established by Harvey. Professor Rudolf Berger, of Berlin, deposited a wreath on the pedestal of the monument in the name of "democratic and liberal Germany." M. Édouard Montet, rector of the University of Geneva, was one of those who spoke of the intolerance of the sixteenth century, and of Calvin's share in the prosecution and condemnation of Servetus. He characterized Servetus as "that Spaniard of genius with the encyclopedic mind," and said that his name had become the symbol of modern toleration. M. Ferdinand Buisson, one of the deputies for the Seine department, described Servetus as having "maintained with sublime simplicity against the pope of Rome and the pope of Geneva the right of free thought and the right to be the servant of his conscience and his reason alone."

The members of the syndicate appointed to consider the provision of pensions for professors and others in the service of the University of Cambridge have issued their report. According to the abstract in the London *Times* they say that while they can not recommend a contributory scheme they propose that the university should establish its own pension fund rather than enter into an arrangement with an assurance company. They have aimed at providing pensions for professors, readers and certain officers on the basis of compulsory retirement at a given age; the maximum pension to be £500 a year, or five sixths of the stipend, whichever is less, and to be inclusive of any college pension, stipend or emolument. They recommend that 70 should be the age at which retirement should be required, but they think that, if and when funds are available, this age should be lowered to 68 or even 65. Their main recommendations are: (1) That every professor, reader and university officer appointed to an office included in one of three schedules should be required to retire at the end of the academic year in which he attains the age of 70, and should receive a pension if he has served in the office of professor, reader or university officer for 15 years in all. (2) That professors and readers retiring at the age of 65 should become emeriti professors and readers without statutory duties and powers. (3) That professors with a stipend of £600 or more, the university librarian and the registrar should receive a maximum pension of £500 a year, and other professors, the readers and the other university officers a maximum pension equal to five sixths of their stipend. (4) That professors, the readers and the university officers should receive as a pension an annual payment equal to one twenty-fifth of the maximum pensions for each year of service. (5) That professors, readers and university officers under the age of 60 when the scheme comes into operation shall have the option within a year of joining the scheme.

THE *Geographical Journal* has received accounts of the progress of Dr. Zugmayer's expedition in Baluchistan. He went westward by Sumiami to Bela, and thence to Gondrani (where he examined the remarkable cave-dwellings), reaching Ormara on April 20. He found the people of this region extremely primitive in their mode of life. Gwadur was reached towards the end of May, and the second stage of the journey, the crossing of Baluchistan in a northeasterly direction, then began. Intense heat was experienced, temperatures of 127° F. in the shade and 158° in the sun being registered. Particularly trying were the hot sand-storms, during which travel is quite impossible, the human body losing more than a liter of water per hour by evaporation when they are at their height. In spite of all difficulties, Dr. Zugmayer was able to secure valuable collections of animals and plants, and also to make important zoogeographical observations in a region which is the meeting-point of the European, Inner Asiatic and Polynesian realms. Crocodiles were met with up to the Persian frontier, but land-snails and *Salmonidæ* were absent. Rats also were entirely wanting, though epidemics of plague are frequent. The traveler is inclined to connect the epidemics with the arrival from the north of vast flights of ducks, and he endeavored to obtain evidence as to the possible rôle of these as disseminators of plague, and also to find a reason for the visit of such birds in summer to such a burning region. On June 22 the caravan reached the small garrison of Turbat, and the worst of the heat was then left behind. Climbing a pass, the party reached the interior plateau of Baluchistan, attaining an altitude of over 3,000 feet, with a proportionately lower temperature, at Shakrok. The inhabitants of this interior region presented a marked contrast with those of the coast lands in their higher culture. The date-palm here supplies the staple article of diet, and its harvest is celebrated by festivals. Panjgur was reached on July 6, and was made a center for collecting trips and haunts. Dr. Zugmayer expected to be back at Karachi at the end of October, traveling by way of Kelat and Quetta.

UNIVERSITY AND EDUCATIONAL NEWS

THE will of Miss Emma Carola Woerishoffer leaves $750,000 to the trustees of Bryn Mawr College, of which she was a graduate.

THE estate of John S. Kennedy is even larger than has been previously announced. The share of Columbia University is $2,429,943. The New York Public Library receives $2,779,790; the Metropolitan Museum of Art, $2,929,943; the Presbyterian Hospital, $1,514,086; New York University and the Presbyterian Board of Aid for Colleges, each $976,647; Robert College, Constantinople, $1,847,295. The specific bequests, not dependent on the size of the estate, include $100,000 each to Yale, Amherst, Dartmouth, Bowdoin, Hamilton and Glasgow.

WILLIAMS has received a gift of $35,000 from the estate of Mrs. Frances E. Curtis for the endowment of the Edward Brust professorship of geology and mineralogy.

ABOUT $1,000,000 has been collected for establishing a residential Hindu University at Benares with an adequate European staff.

GROUND was broken last week for the Wolcott Gibbs Memorial Laboratory of Harvard University. This building, designed for research in physical and inorganic chemistry, will cost when completed about $72,000. It was given and endowed by Dr. Morris Loeb, Mr. James Loeb and many other friends of Dr. Gibbs and the university.

THE Association of American Universities met at the University of Chicago on October 26 and 27.

THE budget of Oberlin College for the ensuing year contains a special appropriation to be used in defraying the expenses of administrative officers, professors and associate professors who wish to attend meetings of educational and scientific societies.

NEW laboratories, completely equipped for post-graduate medical instruction and research, have been organized and opened at the

New York Post-Graduate Medical School and Hospital. The director is Jonathan Wright, M.D. (Columbia), and the staff includes—tropical medicine, in collaboration with the medical departments of the Army and Navy: James M. Phalen, M.D. (Illinois), captain Medical Corps, U. S. A., F. M. Shook, M.D. (Michigan), P. A. Surg., U. S. N.; bacteriology: Ward J. MacNeal, Ph.D., M.D. (Michigan), Richard M. Taylor, M.D. (Michigan); pathology: Ward J. MacNeal, Ph.D., M.D., Oliver S. Hillman, M.D. (McGill); biochemistry: Victor C. Myers, Ph.D. (Yale), M. S. Fine, Ph.D. (Yale).

Cornell University Medical College opened with an enrolment as follows: For the degree of M.D.: first year, 32; second year, 23; third year, 20; fourth year, 11. Special students (work not leading to the degree), 19. Doctors of medicine engaged in research, 9. A total of 114. There is a loss in numbers as compared with the preceding year which is due to the fact that all matriculants for the degree of M.D. now registered are admitted under the advanced requirements necessitating the presentation of a bachelor's degree in science or arts, together with something more than one year's work in physics, chemistry and biology. With the exception of those first-year students at Ithaca who are pursuing the combined seven-years' course leading to the degree of A.B. and M.D. all students now registered in this college are graduates in arts, science or medicine.

Dr. Harlan H. York (Hopkins '11), formerly instructor in botany at the University of Texas, has been made associate professor of botany at Brown University, in charge of the department.

At the Colorado School of Mines, George W. Schneider takes the position of professor of mining and Carl A. Allen that of assistant professor of mining. Both are practical mining men and former graduates of the school.

Mr. B. Tatarian, formerly instructor in the University of Illinois, has been appointed assistant professor of chemistry in the University of Arizona.

Carl L. Rahn, Ph.D. (Chicago), of the University of Pittsburgh, has been appointed instructor in psychology in the University of Minnesota.

At the University of Texas Dr. N. H. Brown succeeds Dr. A. C. Scott as head of the School of Electrical Engineering. Newly appointed instructors are: In physics, Dr. H. L. Brown, of California, succeeding Dr. C. L. Shuddemagen; in zoology, Dr. A. Richards, of Princeton; in electrical engineering, J. W. Ramsey, of Texas.

Dr. Karl Linsbauer, of Czernowitz, has been appointed professor of the anatomy and physiology of plants at the University of Gratz.

DISCUSSION AND CORRESPONDENCE

THE NEEDS OF METEOROLOGY

The session of the German Meteorological Society, held at Munich, October 2, included memoirs of general interest. Among these that by Professor Moeller, of Brunswick, appeals especially to Americans. His theme was the same as that which I have so often presented to American audiences, namely, "The Need of the Establishment of an Institute for Theoretical Meteorology."

For forty years I have indulged the hope that some intelligent American merchant would show his appreciation of the successful efforts of the practical meteorologists of our unrivalled Weather Bureau, and would establish a school of meteorology comparable with our great schools of astronomy, engineering, etc. But now I fear that Dr. Moeller's address may result in the founding of the German Institute that he wishes, long before our American establishment is under way.

The money value of meteorology began to be realized by American merchants when Maury studied the winds and currents and shortened the voyages of American clippers by 50 or 100 days. The money value of the modern Weather Bureau has been recognized during every storm and blizzard and frost and flood since January, 1871. The future of aerial

voyages, the hoped-for success of the aeroplane in war and in peace, the development of agriculture, the safety of our vessels, all depend on our knowledge of the atmosphere, and our anticipation of its vagaries.

We have done wonders on land and sea, on the mountains and underneath the oceans, but we have scarcely begun to appreciate what we may do in the atmosphere. We may not change its winds, its rains and snows, but we may learn to utilize them to advantage. The investment of a half million dollars in one laboratory, with its physicists and mathematicians devoted to research in the physics and mechanics of the atmosphere, would do for meteorology as much as the wonderful observatory at Mount Wilson is doing for astronomy.

One hundred years ago James Smithson of England entrusted his fortune to the United States as executor of his will, and from that evidence of his faith in America, innumerable benefits have followed. How long will it be before meteorology receives a corresponding attention?

The state of New York has furnished such men as Myer from Buffalo, Henry from Albany, Redfield from New York—eminent students who died without realizing their fondest hopes. Americans are profiting unconsciously by their labors in meteorology. Will they not invest 1 per cent. of their earnings in the promotion of an institute devoted to man's progress in this important science? They can do nothing better for humanity.

C. Abbe

MORE BOTANICAL ERRORS

Professor Newcombe's communication entitled "Professor Punnett's Error," on page 442 of the present volume of Science, prompts me to call attention to the fact that Punnett is not the only zoological writer who displays ignorance of elementary botanical facts. Two books in common use in our universities exhibit the same error as Mr. Punnett's book. One of these, "The First Principles of Heredity," by Dr. Herbert, contains the following exposition (page 21): "Among plants we find male and female germ-cells in all flowering species—the former, the pollen-grain, being developed in the anther of the stamen of the flower; the latter, the ovule, lying in the ovary, to which the pistil leads. Most flowers possess both sexual organs, stamen as well as pistil; . . ." It will be sufficient to point out three of the patent misconceptions in this extract: (1) the pollen-grain and ovule are not germ-cells; (2) the stigma or style, not the pistil, leads to the ovary, which is itself part of the pistil; (3) stamen and pistil are not sexual organs, for they bear *asexual* spores. The second work referred to is E. Davenport's "Principles of Breeding." On page 161, speaking of the ovum, the writer says "Its equivalent in plants is the ovule." In the next paragraph the writer says that the spermatozoon is "the functional equivalent of the pollen grain of plants." The errors here involve the same misconception as in the first case, but are less serious.

Botanists of course regret that the term ovary should have been wrongly applied to the sac which contains megasporangia, but the usage seems to be here to stay, and certain of our zoological brethren might well consult a dictionary when dealing with botanical topics.

M. A. Chrysler

"WASHINGTON SCIENCE"

Under the above caption which is assumed to have "depreciatory significance," "Washingtonian" "who has spent nearly half a century in scientific work, under government auspices" writes[1] defending government scientists.

It is with pleasure that I endorse every statement of his article and in many cases I could add much more of commendation from my personal knowledge. It is suggested that "outsiders" can help if they will to promote the ideal service, hence I have attempted to define what "depreciatory significance" the above title might have in my mind and to suggest a remedy.

It seems to me that the difficulty is one of

[1] Science, N. S., XXXIV., 405, September 29, 1911.

coordination, as far as the relation of industrial organizations to government science is concerned, arising from the fact that scientists in the government bureaus often have no adequate knowledge of the industries affected by the regulations which they are called upon to draw up and enforce and hence they are not in a position to properly distinguish between attempts to evade the law and real protests concerning unnecessarily restrictive rulings. Very few business concerns are engaged in anything comparable with the sugar trust frauds or would countenance anything of the kind, yet "Washington scientists" are apparently unduly influenced by such cases and do not appear to give sufficient thought to the thousands of concerns with whom they never have any trouble.

The remedy for this condition would appear to lie in the employment of a number of scientists in the executive work of the bureaus who have had adequate training in the industries affected, in place of the present plan of selecting all scientists for government work from men who have devoted their entire previous time to theoretical study and teaching.

In the ultimate analysis the industries of the country appear to be the financial foundation upon which our government rests, hence I would suggest that inhabitants of the structure occupying "top floor front rooms" should be a little more conservative in their treatment of this same foundation.

Industrial Engineer

THE METHODS OF AMERICAN ETHNOLOGISTS

To the Editor of Science: American students will welcome the views propounded by Dr. Rivers in his presidential address before the Anthropological Section of the British Association for the Advancement of Science (Science, September 29, 1911). Nevertheless, were Dr. Rivers telescopically gifted, he would assuredly read nothing but amazement and surprise in the expression of American ethnologists' eyes as they peruse his extraordinary characterization of their activity as compared with that of their colleagues in other lands.

Dr. Rivers's paper is essentially a declaration of independence from the traditional point of view of his compatriots, who, to use his own words, have been "inspired primarily by the idea of evolution founded on a psychology common to mankind as a whole." His own investigations in Melanesia have converted Dr. Rivers to the teachings of the geographical or "ethnological" school, whose home, past and present, he finds in Germany. He has arrived at the conclusion that a direct psychological interpretation of cultural phenomena is impossible, because it ignores the demonstrable blending of different cultures. Psychological analysis, he contends, must be preceded by an ethnological analysis: ". . . if cultures are complex, their analysis is a preliminary step which is necessary if speculations concerning the evolution of human society, its beliefs and practises, are to rest on a firm foundation" (p. 391).

Apparently, Dr. Rivers has never met with any thing like such views in the writings of American ethnologists, for among these he recognizes only either purely descriptive recorders of data concerning the Indians, or writers who, like Kroeber in his "Classificatory Systems of Relationship" and like Goldenweiser in his "Totemism: an Analytical Study," investigate social problems from a purely psychological point of view.

Now, as early as 1895, Dr. Boas was led by his study of mythology to an expression of opinion so closely resembling the recent utterances of Dr. Rivers that it is almost inconceivable how the resemblance could fail to be noticed. At the conclusion of his "Indianische Sagen von der nord-pacifischen Küste Amerikas" (p. 353), Boas emphatically protests against a direct interpretation of myths as expressions of universal ideas before investigating the historical and geographical causes conditioning the growth of mythological tales. A still more comprehensive statement appears in the same writer's "Introduction" to the "Publications of the Jesup North Pacific Expedition" (Vol. I., 1898–

1900): "We are still searching for the laws that govern the growth of human culture, of human thought; but we recognize the fact that before we seek for what is common in all culture, we must analyze each culture by careful and exact methods, as the geologist analyzes the succession and order of deposits, as the biologist examines the forms of living matter."

It is not too much to say that during at least the last decade Professor Boas's point of view has dominated the ethnological work of the younger ethnologists of this country. American ethnologists have been well aware of the opposition of their methods to those of the traditional evolutionary school, as might be gathered from Wissler and Lowie's annual survey of anthropological activity in *The New International Year Book* (for 1907 and 1910) or the present writer's comments on Schurtz's and Webster's theories as to the development of secret societies ("The Assiniboine," p. 75). Nor has this *American* point of view been without influence on detailed ethnographic study. In the investigation of the Plateau area, the doctrine of a blending of cultures has been the theoretical peg on which we have hung our facts. This view is dominant, for example, in Dr. H. J. Spinden's monograph on the Nez Percé. It is certainly still more remarkable that this geographical attitude common to many American students should have escaped Dr. Rivers's attention even in one of the two American papers specifically referred to by him. For Goldenweiser's investigation of totemism is not only permeated by the spirit of the historico-analytical method, but includes, in the final chapter, an emphatic protest against any other method of inquiry for the reconstruction of cultural development.

Nevertheless, questions of priority or misunderstanding are relatively unimportant. The significant fact remains that one of the most distinguished of English ethnologists now finds himself in substantial agreement with the position generally held in America.

ROBERT H. LOWIE
AMERICAN MUSEUM OF NATURAL HISTORY

QUOTATIONS

REFORM IN COLLEGE ENTRANCE REQUIREMENTS

THREE notable reports, dealing with requirements for admission and the relation of these to the high-school curriculum, were made at the last meeting of the New England Association of Colleges and Preparatory Schools at its recent meeting held at Cambridge, October 13 and 14.

President Lowell's report on the operation of Harvard's new alternative method was of especial interest inasmuch as it gave the first results of the test of the new plan. This plan aims to get into closer touch with the high schools, especially those in the west, rather than the private fitting schools, by giving the secondary school greater freedom in courses and methods of study. President Lowell reported that there were 206 applications for admission under the new plan. Of these 66 were refused admission upon their school record. Of the 140 allowed to try, 57 were rejected, 83 admitted. In other words, a larger number of candidates was refused admission under the new plan than under the old. Moreover, several students rejected under the new plan in June were admitted under the old regulations in September.

As to the geographical distribution of candidates: under the old plan 84 9/10 per cent. came from New England states, 8½ per cent. from the other Atlantic states and but 4½ per cent. from the western states. Under the new plan, 47 per cent. of the candidates came from the New England states, 41½ per cent. from the Atlantic states and 21½ per cent. from west of the Alleghenies. As to the character of preparatory school: Under the old plan, 54 per cent. of Harvard's students came from private fitting schools, 45 per cent. from public high schools. Under the new plan there were 15½ per cent. of the candidates from private schools and 83½ per cent. from public schools.

In sharp contrast with the requirements and methods of Harvard and the other eastern examining colleges is the new method of admission to the University of Chicago as reported at the same meeting by Professor Judd and the plan proposed by the National Educa-

tional Association. These two reports indicate the increasing differences between the eastern and western college. Some of the differences are, of course, evident. Practically all students of western colleges are prepared in public schools and are admitted on certificate, whereas the New England "examining" colleges depend very largely upon special fitting schools. But the more radical and far-reaching distinction between colleges of the east and the west arises from the fact that the more conservative of eastern colleges still prescribe a large proportion of the subjects and methods of the preparatory school. The western college, on the other hand, has in large measure accepted the dictates of the high school and has practically surrendered the right of intervention in the courses of preparatory study.

This position of the western university is well shown and ably defended in the reports just referred to. They urge that the requirements for admission should be entirely divorced from *subjects* and that the college should confine itself to stating the number of units required. In other words, the college should content itself with stating the *process* and *time* requisite for preparation rather than the *content*.

In view of the prevalence and strength of this "insurgent" movement in the western institutions there can be little question that these plans and methods will be urged upon the eastern colleges. To the conservative, the measures adopted and advocated seem absurdly radical and subversive of sound education, but he recalls that the high school curricula, except in very restricted areas of influence, go their own way with little or no consideration of college requirements, and that in the long run the high-school man has usually dictated the requirements for college. A preparation for college, however, which did not include foreign language or mathematics (except arithmetic) and with more than half of the school course represented by commercial and vocational studies would seem to him to be a misnomer. There can be little doubt that such extremes bear the seeds of reaction; but this does not relieve the eastern college from the responsibility of making its entrance requirements such as not to bar it from intimate connection with the public-school system of both the east and the west.—Professor Robert N. Corwin in the *Yale Alumni News*.

SCIENTIFIC BOOKS

An Investigation of the Rotation Period of the Sun by Spectroscopic Methods. By WALTER S. ADAMS, assisted by JENNIE B. LASBY. Carnegie Institution, Washington. 1911.

This publication gives a complete account of the investigations undertaken at the Solar Observatory of the Carnegie Institution, Mount Wilson, Cal., upon the Rotation of the Sun in the years 1906–07 and 1908, embodying results previously published in the *Astrophysical Journal* and in the "Contributions from the Mount Wilson Solar Observatory." These, however, contained only brief summaries of the principal portions of the work which is treated in detail in an admirably comprehensive and yet concise and logical manner in the publication under review. The arrangement of the material in this work and the plan of treatment of the numerous observations recorded is one that might with advantage be copied in reports of scientific investigations which are too frequently lacking in the logical treatment necessary for the proper exposition of the results obtained.

After a succinct and yet complete account of the work previously done on the spectroscopic determination of the solar rotation, the instrumental equipment used in the two series of determinations is described. The first series in 1906–07 was made by means of the "Snow" cœlostat telescope and an 18 foot focus, Littrow form, grating spectrograph. The second series, which, as the author claims and the observations show, is superior in accuracy to the first, was made in 1908 with the 60-foot Tower telescope and a 30-foot focus grating spectrograph also of the Littrow form. The linear dispersion for the first series at λ 4250, the center of the region employed, was 1 mm. = 0.71 Å., and for the second 1 mm. = 0.56 Å., comparatively high dis-

persions, the latter giving a maximum displacement, at the solar equator, of about 0.090 mm.

Considerable space is devoted to a discussion of the possible sources of error and it is evident that the greatest possible care was taken to avoid all known causes of systematic displacements of the lines and consequent error in the velocity. In most astronomical work systematic errors are much more to be feared than accidental errors and this is especially true in this case where the line displacements to be measured are small. The greater relative importance of what might be called plate errors over the accidental errors of measurement is clearly shown by the results obtained in this investigation, where the probable error of the mean value of 21 plates is considerably less than the probable error of a *single* plate as determined from the internal agreement of the 22 lines on the plate—a ratio of plate errors to measurement errors of more than five to one. The method of measurement and reduction is concisely and yet fully described and is followed by the detailed measures of the plates obtained in the two main and two supplementary series which are then conveniently summarized.

The discussion of these results is admirably arranged so as to present in a convenient form the conclusions reached, the most interesting and important of which may be briefly stated.

1. So far as the period covered by these observations goes, the sun's rate of rotation is constant, the slight difference found in the two series being ascribed to the slightly less satisfactory instrumental conditions in the first series.

2. The retardation of the rate in higher latitudes is satisfactorily represented by an equation of the Faye type taking the form for these observations of

$$\xi = 11^\circ.04 + 3^\circ.50 \cos^2 \phi$$

where ξ is the daily angular sidereal velocity and ϕ is the solar latitude.

3. The lines of different elements in the reversing layer give different values of the rotational velocity, which, though small, are believed to be real, those known to lie at low levels giving low values, and *vice versa*. This is especially the case with H_α and Ca λ 4227, which move at a more rapid rate than the general reversing layer and in which the retardation towards the higher latitudes is very much less.

4. The comparison of H_α, λ 4227 and lines in the reversing layer shows that the velocity increases and the polar retardation decreases with increasing distance outward, the cause being assigned as probably due to the effects of friction in the lower portion of the solar atmosphere.

The whole work sets an exceedingly high standard of accuracy, which it will be difficult for other observers to equal. Taking for example some of the probable errors of measurement obtained, we have in the second series the probable error of measurement of the displacement of a single line ± 0.009 km. per sec., equivalent to a linear error of only about 0.0004 mm., less than half a micron. Those who have had experience in measuring spectrum lines where a probable error of a micron is considered good measuring will recognize the remarkable accuracy obtained, several times greater than previously secured in the same problem. The corresponding error of a plate is ± 0.002 km., the thousandth part of the equatorial velocity. Notwithstanding what was previously said concerning systematic displacements the agreement among different plates is also remarkably good, the probable error of a single determination of the rotational velocity being not much greater than ± 0.01 km., giving the probable error of the mean value of the velocity in the neighborhood of ± 0.003 km.

Professor Adams and Miss Lasby are to be congratulated upon the very high accuracy of this determination of the solar rotation, upon the interesting and important conclusions derived from their measures, and upon the manner of presenting the formidable amount of material on hand. Furthermore, they, with the Carnegie Institution, are to be

congratulated on the mechanical excellence of the completed volume.

J. S. Plaskett

Dominion Observatory, Ottawa,
October, 1911

Photography for Bird-Lovers: a Practical Guide. By Bentley Beetham, F.Z.S. With Photographic Plates. London. 1911. Pp. i–vi + 122.

This handy little volume is designed to serve as a manual and guide in bird-photography in its widest sense, and while addressed to beginners in the art, and to lovers of birds and of sport rather than to ornithologists and trained naturalists, all interested in birds will find in it much to attract them. More particularly, the expressed object of the author is to show how pictures of birds, whether dead or alive, captive or free, can be best obtained, rather than to direct the steps of his reader into the paths of the naturalist, to show him how to study, and to use his camera as a tool for recording and supporting his observations.

In every such work we should like to see it clearly stated that the higher object of bird-photography is not simply to "embody a little story," or even "to portray the living bird in some characteristic pose or action," though this be all very well, but rather to obtain a pictorial analysis of behavior, as registered in all the more characteristic movements and attitudes, made or assumed by birds. This, 'tis true, is a subject which requires ample leisure as well as training and skill, but one, it would seem, in which many young students, who, happily possessing the former, might be led to acquire the latter, and thus to extend the boundaries of knowledge. We think that the attitude of any author could be raised to this plane without loss in interest, and with decided gain in value.

Some of Mr. Beetham's specimen illustrations, and particularly the habitat pictures, which show the nest or bird with its surroundings, could hardly be improved, such as the oyster catcher's eggs on page 28, or the grouse on page 56, obtained by setting the camera very low down. I think, however, that the value to students of all really excellent photographs of this character would be enhanced by adding, either on the page or at the end of the book, the essential photographic data, a thing usually neglected.

If one were disposed to be critical, though we hope, not hypercritical, he could find more exercise of this power in the longest and most important chapter in the book, that on the use of the concealing tent. The present reviewer, so far as he knows, was the first to use a *bona fide* unadorned tent for the close at hand study of birds, in the summer of 1899, so that perhaps he is a little over keen on the subject. In a work on the "Home Life of Wild Birds," published in 1901 and again in 1905, the bird-tent was fully described and illustrated, with an exposition of the psychological principles governing its use. Many were inclined to look askance upon our tent and methods in 1901, but no attempt seems ever to have been made to dispute the principles at stake. All this, however, is a matter of history, and we are now interested to see that our tent has become a fixture for the intimate study of nest-life, and further that at the end of this very volume a "hiding tent" is advertised for sale by a London dealer. To continue, the present writer's tents, plain and unadorned, have been in use—one of them at least—for twelve years, and with them he has worked at the close range of 70 nests, pertaining to from 30 to 40 species of wild birds, often spending a week at a given one. Further, since accidents from every cause, including the weather and living enemies, have hardly exceeded one in ten, and can be reduced to almost nothing by a proper use of the wire screen whether the original position of a nest is changed or not—he should be qualified to speak on the score of experience at least.

The use of the concealing tent is indeed based upon certain fundamental principles, the force of which experiments in the field, year after year, have only tended to confirm. While any detailed discussion of them would be quite out of place here, we might intimate that the most important are the gradual rise of the "parental instincts," and consequent depression of fear, most marked from the beginning of incubation, the force of habit, and

the freedom with which new habits are formed. All procedure is to be directed upon this basis, with variations, if need be, to suit the species or the individual and the state of its instincts at the time. We know, for instance, when to successfully approach with the tent the cuckoo or the cedar waxwing, when, the herring gull or the tern, for experiment has shown how they may be expected to behave under certain conditions. We have never found "concealing the tent," to which Mr. Beetham devotes a section, necessary, when the element of time was no object, two hours being usually enough to indicate the character of approach permissible. Nor have we ever needed "dummy cameras," nor had to consider "a comfortable position," when using the tent. So far as comfort is concerned, we cut the Gordian knot long ago, and should never think of using anything but a commodious tent, in which any one can stand, sit, write or read at ease, and be as comfortable as the temperature will permit.

If birds are to become accustomed to the tent itself, any question as to its size, form, or even color is of little consequence to them. The occasional nesting of many kinds of birds in incongruous, noisy, or even dangerous situations surely ought to have made this fact clear. A wall-tent of convenient size, such as we have always used, supported by a compact folding frame, guyed and pinned below, is certainly the best model for general use.

With many species indeed, an abrupt approach with a plain, unadorned tent is permissible, whether the original position of the nest be changed or not, while in other cases a more gradual access, with the use of a certain degree of finesse, is as clearly demanded for complete and assured success. In any case our procedure will depend very largely upon the strength of the parental instincts, or the condition of eggs or young. The depression of fear and consequent rise of the brooding and other instincts is expressed by fairly definite curves in a given species, and in entire ignorance of such conditions it would be hazardous to pitch any sort of a tent within a few feet of any nest, particularly when there were eggs, and fresh ones at that. On the other hand most birds with advanced young can be easily approached with the tent, without effort to conceal it, whatever the nest's position. In such cases the point is, not to cover the tent with leaves and other "familiar objects," but to make it a familiar object itself, a part of the landscape, as it were; in many cases the birds come to alight on it as they would upon rock or tree. Instinct may excite fear in the unfamiliar, but then habit commonly steps in to allay it, and that often in a surprisingly short time.

Mr. Beetham's experience with the lapwing is instructive, and one which has been repeated many times when we have been working with gulls, cedar waxwings and other wild species. In this instance the fear of a timid bird is gradually allayed by habit, until it becomes indifferent to sounds of whatever violence, and although close to the fixed eye of the camera, it is not readily driven off unless by some decisive movement, as by striking the wall of the tent or waving a hand outside. In all such cases, however, the obvious corollary does not seem to have been drawn, namely, use a tent of convenient size, and trust to habit to "conceal" it.

The author's chapters on work upon cliffs by the aid of ropes, and upon the rapid photography of birds in flight are excellent, but we should have liked more explicit information on the subject of cinematography, or the making of "moving pictures" of birds, since this is a subject about which very few naturalists are informed, in this country at least; ordinarily one might as well consult a graven image for the desired information as any oracle of a trust-controlled business. My own experience in the field has shown that moving pictures to record the activities of life at the nest are readily made, provided the birds have been subjected to the proper training, after methods which we worked out many years ago, when no muffling of the machine, or dummy "musical box," such as the author describes, is commonly necessary: nor should we ever think of covering the protruding legs

of the tripod with vegetation, for, if the reader will transpose,

"A primrose by the river's brim
A yellow primrose was to him,
And it was nothing more."

Francis H. Herrick

Travels in the Confederation (1783–1784). From the German of Johann David Schoepf. Translated and edited by Alfred J. Morrison. Philadelphia, William J. Campbell. 1911. 2 vols. $6.00.

Few, if any, of the early travelers through America showed a wider mental grasp on matters falling under their observation than did Dr. Johann David Schoepf, a surgeon to the Bavarian troops employed by the British government in their vain attempts at subduing the unruly Americans during the war of the Revolution, and who subsequent to the declaration of peace made, for that period, extensive journeys through the eastern and southeastern United States. Schoepf was no mere specialist. His training had been broad and he lived at a time when it was possible for one mind to grasp and perhaps master the essentials in all branches of science. That he was a man of more than ordinary powers of observation and scientific acumen is evident from his published writings, which cover a wide range in ethnology, meteorology, biology, botany and geology. He was, according to Goode, the author of the first special ichthyological paper ever written in America or concerning American species, while his "Beyträge zur mineralogischen Kenntniss des ostlichen Theils von Nord Amerika" (1787) was the best systematic record of the geology of the eastern United States that had appeared up to date. The breadth of the man, however, is nowhere shown to better advantage than in the work now under review. "I willingly admit," he wrote, "that these notes are neither so complete nor of such importance as I could wish, but . . . to be candid, the motive of my journey was curiosity."

Whatever the motive, it is difficult to conceive of his getting into readable form and in a limited space a greater amount of information on a variety of subjects than here, and a hearty vote of thanks is due Dr. Morrison for thus bringing to life, resurrecting, as one may say, a story of travel which might otherwise remain inaccessible to most readers and hence be forgotten.

After seven years of garrison duty Schoepf began his *Reise* in July, 1783, by boarding a flat-bottomed water craft known as a "petty augur" bound for Elizabethtown, New Jersey; thence by various modes of conveyance he proceeded through the state into Pennsylvania as far west as Pittsburgh and southward into Maryland, across the Potomac into Virginia, the Carolinas and from Charleston by boat to Florida, returning by way of the Bermudas to Europe. His narrative is in form of an itinerary and is really extraordinary in its detail. No object or item was too small for his consideration, or apparently too large for his comprehension. He noted the general physical features of the country passed over, its climate, mineral productions, soil, vegetation, animal life and the cities and towns and their manner of government. The character of the people and their personal idiosyncrasies are discussed in a way comparable only with the later writings of Featherstonhaugh in his "Journey through the Slave States" (1839), though from a less cynical standpoint. He seemed not favorably impressed by the German farmers of Pennsylvania. "They give their children no education." "Their conversation is neither interesting nor pleasing." With the people of Virginia he is likewise disposed to be critical, but considers their objectionable characteristics as in part due to the debasing influence of slavery. The Assembly he did not find impressive. "Among the orators here is a certain Mr. Henry." (Presumably Patrick—he of "Give me liberty or give me death" fame.) "He has a high-flown and bold delivery, deals more in words than reasons, etc." Charleston, South Carolina, in spite of a climate which he states makes it in spring a paradise, in summer a hell, and in autumn a hospital, is described as one of the finest of American cities, and, Philadelphia excepted, inferior to none.

The geology given is naturally largely of a mineralogical nature, though the possible effects of uplift and erosion were partially comprehended. The following description of the marble beds of Swedes Ford, Pennsylvania, is characteristic:

> These strata, resting one upon another almost perpendicularly, are very clearly distinguished by divers rifts and clefts as well as by changed colors. This can scarcely have been their original bearing; rather it is likely they have suffered a powerful alteration in their bed.

Copious notes are given on the mineral resources, together with descriptions of mines and remarks on the condition of the metallurgical industry and the effects of tariff legislation. The need of a "trust buster" was evidently manifest even at that early date. Concerning an unsuccessful attempt to check imports by high duty on the part of the iron workers of New Jersey and Pennsylvania we are informed:

> Therefore several of the larger furnace and forge masters proposed to hinder the further import of foreign iron by coming to an agreement among themselves that whenever iron came in from Europe they would offer their own at a certain loss under the prices of the European merchants so as to frighten them off from further imports.

The volumes are of convenient size, good paper and type, and the rendering into English well done. It is a work which those interested in the beginning of science, or the early history of the country may peruse with pleasure and which all may read with profit. One can but hope that it will meet such a reception as may lead to a like rendering by Dr. Morrison of the "Beytrage" above mentioned.

GEORGE P. MERRILL

THE INTERCOLLEGIATE GEOLOGICAL EXCURSION

THE eleventh Intercollegiate Geological Excursion, though it began on "Friday the 13th," was blessed with perfect weather and the attendance was over 70. We regretted the absence of Professor William Morris Davis (to whom a greeting was sent) and Secretary Professor Cleland (detained at the last moment) yet the presence of Dr. C. A. Davis, the peat expert of the Bureau of Mines, and David White, from Washington, and a delegation headed by Professor Chadwick from St. Lawrence University, helped to make up. The state geologists of Connecticut, Rhode Island and Vermont (there is none in Massachusetts) were present and members of the faculties of Dartmouth, Vermont, Amherst, Smith, Mt. Holyoke, Yale, Worcester, Boston and Salem Normals, as well as the immediately adjacent institutions of Harvard, Tech. and Wellesley. Professor Lane, of Tufts, had charge of the excursion.

Starting Friday noon from Davis Square, Somerville, at Morrison Avenue a diabase dike ridge of La Forge's "Older" E.W. family was visited, then at the corner of Francesca Avenue was a temporary exposure showing the Somerville slates beautifully glaciated and the preglacial weathering not entirely removed, a north striking camptonite dike with brotocrystals of biotite and an older labradorite porphyrite. Then near the old powderhouse the diabase with quartzite inclusions was shown on the terraces and its peculiar spheroidal weathering. This was visited again at Governor's Avenue in Medford and unpublished analyses by C. N. Whitney, showing that the weathering is largely oxidation and hydration without leaching, were shown that evening by Professor Lane, who called attention to the fact that the phosphorus seemed higher in the weathered material and thought that the weathering was in some ways like that of an arid region. He also said that his studies[1] showed that if the consolidation temperature was something like 1100° C., the initial temperature was near 2000°. Thence passing along Broadway, hills and drumlins were being cut away, showing rock core, with accumulation of the till on the lee side exhibiting also some sign of nipping by an old ocean shore 35 feet above the present level.

On Simpson Avenue (Nos. 69 and 31) in temporary excavations for cellars, sections of washed gravel were exposed—largely an

[1] "Die Korngrösse der Auvergnosen."

overwash gravel plain from the ice but a boulder of the weathered diabase and an unconformity were seen—the upper layer being more oxidized and leached, the lower showing more cross-bedding with a considerable amount of hornblende with the quartz, suggesting a beach deposit lying on top of the gravel plain. At No. 69 the underlying slate, *not* smooth and glaciated, was shown.

At the Holland St. quarry Professor Palache showed veins (confined almost to the diabase) in which calcite, quartz, siderite and almost microscopic anatase and other minerals have been found.

Passing over College Hill other sections of till above the 35-foot line and of shearing and jointing in the slate, which on Quincy Street dips nearly vertically and has numerous small faults, were shown. The extensive view from the reservoir shows the peneplain of the Middlesex Fells, the lower land of the Boston Basin, the glacial outwash gravel plain of Arlington, a quarry on the Fellsway in felsite with calcite and specular hematite and barite in veins (later visited), the drowned valley of the Mystic with its salt peat marshes and numerous drumlins. Descending to this valley Dr. Davis pointed out the freshening of the *Spartina patens* salt marsh indicated by the invasion of various fresh water plants. This has all happened in three or four years while the dredge has thrown up signs of fresh water peat at a considerably lower level than the sea level.

Next were visited the Medford diabase weathering on Governor's Avenue and Fellsway quarry and the Wellington clay beds. Here were found two distinct beds of clay with a sand layer between, and above a bed of gravel which Gulliver showed by the per cent. of angular pebbles was undoubtedly glacial outwash. Barton called attention to faulting in the sand and cementing of the sand into sandstone and conglomerate. The Mystic valley is, then, largely filled by this gravel plain and on top of it is the marsh deposit of irregular thickness, sometimes not very deep. In other hollows of the gravel plain we find (*a*) fresh water peat, with sticks and leaves, 10 feet; (*b*) fresh water swamp bed with stumps; (*c*) brackish water swamp, 1 ft.; (*d*) thin high tide *Spartina patens* salt water deposit. Stumps of a former pine forest were very conspicuous near the margin and were connected with a fresh water peat layer pointed out by Professor Davis, on which grew a salt marsh. The evidence that this pine forest had been invaded by the salt marsh was not challenged by any one and the freshness of the pine stumps showed that it was relatively recent, as D. White emphasized.

Professor D. W. Johnson, however, pointed out in the discussion which took place that evening in the Barnum Museum at Tufts College that certainly at Scituate and in some other cases such invasion of salt marsh was due to an increase in tidal range without any subsidence of the land, and that if the tidal range outside a barrier beach was, say 20 feet, in going up a stream that range would gradually diminish, so that if a beach were broken through, or driven back, *or in any way the access of water made more free, the increase in tidal range would take place and produce an effect of apparent subsidence, while mean sea level might not differ.*

The same evening Professor Fernald, of Harvard, gave an interesting account of the flora of Newfoundland,[2] which while it has Labrador and Polar plants, has very few of the Canada flora only seventy miles away across the Gulf of St. Lawrence but has a large percentage of plants of the sandy southern coastal plain from Cape Cod south. There is a bar between Newfoundland and Cape Cod which might have been uncovered when the water of the ice sheet was taken from the ocean.

Professor Johnson gave the account of the development of Nantasket which had already been visited in an earlier excursion[3] and pointed out with very strong argument that the level had remained fixed within a couple of feet for over a thousand years—probably several thousand—derived therefrom. He also

[2] Described in the July *Rhodora*.

[3] SCIENCE, 1906, p. 155.

reviewed some of his recent observations along the Atlantic and European coasts. He emphasized the point not often brought out that most of our evidence of subsidence is referred to high tide, and that a change in the range of tide may show apparent subsidence.

Professor Davis was not able to agree with Johnson. He had found sections of as much as twelve feet of salt water peat formed mainly of *Spartina patens* which only occurs a few inches below high tide and is replaced by fresh and brackish water forms with a very slight elevation, and if the exposure to salt water amounts to more than a couple of hours a day is replaced by another species—*Spartina glabra*. The occurrence of such deposits composed almost exclusively of *Spartina patens* from top to bottom seemed to him to prove almost conclusively a steady subsidence and he presented a bit of evidence for the first time as to the rate thereof. The upper layers of marshes at Neponset and Revere crossed by the railroad show for the upper three inches more or less of the peat particles of cinder from the locomotive so that there appears to have been accumulation of something like three inches in the last fifty years or so.

On Saturday the ferry across Boston Harbor gave an opportunity to see the general physiographic location of the Navy Yard bench mark which according to Freeman shows subsidence. This is explained by Johnson as presumably due to a higher range of tide owing to the filling of the Back Bay, etc., which once led off the waters. The question as to the effect of wharves and embankments on the high tide was discussed.

The train gave very good views of sections of drumlins and at Revere Beach, the site of Cherry Island (now entirely washed away) was noted, and the peculiar scallops on the shore. These are explained by Johnson and Lane as due to the waves taking advantage of irregularities and in breaking making sidewise fountains, as they may be called, which extending laterally have a limit of breadth depending on the height and size of the waves. On the back side of Revere Beach the once forested swamp showed stumps and on top a salt marsh turf. New ditches showed the section of the turf and the creeks which drained the marsh showed how sensitive to level the flora was, because in any small depression there was the *Spartina glabra* while on the knolls around the stumps was a more complicated flora with goldenrod and asters creeping in. The salt water peat had a strong odor of sulphureted hydrogen and the darker peat at the bottom showed brackish water formations.

Around Oak Island (a large group of trees slightly above tide level) no rim of stumps was seen as would be expected, except a few poorly preserved stumps of oak and hickory. The salt peat was shown to contain only the roots and underground parts of the plant, not the leaves and aerial parts as the fresh water marshes because they were swept bare by the tide. Beneath this part of the marsh was about 9 feet of salt water peat in general and in order to explain it as not due to continuous subsidence Professor Johnson had to explain it as due to subsidence of several feet several thousand years ago followed by an apparent subsidence of a foot or two more recently due to the changes of the run of tide. The objection to this was that no marked break was found as might be expected.

In a partly cut away drumlin Professor Perkins recognized some boulders, similar to the Vermont red sandstone, which may be of Cambrian age.

On the way from Revere Beach to Nahant a brief stop enabled one to see the ripple marks and rills and other phenomena of the Lynn Beach.

At Nahant was visited another salt marsh which is fourteen feet deep with two feet of sedge and twelve of salt marsh peat. On the golf links relics of stumps were again visible. The beach connecting Bass Point showed the high water scallops once more and Professor Johnson gave an account of their formation and some experiments he had made in producing artificial scallops.[4] At low tide this beach is said to show peat passing under it and Professor Johnson explained such peat

[4] See *Geol. Soc. Am. Bulletin*, Vol. 21, pp. 599–624.

found out under the waves, by consolidation and depression as the barrier beach worked over them, describing a place where wagon tracks occurred. Of course, Professor Johnson does not deny that there has been subsidence and peat formed at lower levels, but probably several thousand years ago.

After dinner Professor Lane took charge of one party (while others studied the peat) and showed typical gabbro and various diabase dikes. He called attention to the basaltic columnar structure of some of these dikes and also a jointing which enabled one to obtain the dip of the main gabbro mass itself. Bass Beach and Canoe Beach both offered excellent opportunity to see the beach scallops in formation. Passing on to Pulpit Rock the finer grain of the gabbro near the contact was noticed and its contact with siliceous and argillaceous limestones changed to epidote and garnet rocks and black basanite. Some of the party found Hyolithes while others passing back along the north shore of the island had a good chance to observe the differentiation of the gabbro into a salic or syenitic phase (which Professor Lane called a gabbro aplite) and a dark peridotic phase near Black Mine. There were numerous other points of interest which attracted some of the crowd (which gradually dispersed) such as faults and the comparison of the rounding of the pebbles with those of the overwash gravel plain.

E. H. & A. C. L.

SPECIAL ARTICLES

A NEW MINNOW FROM COLORADO

A small fish collected by Mr. Horace G. Smith at Julesburg, Colo., has been the occasion of much correspondence and discussion, but may now be brought forward as apparently undescribed.

Notropis horatii n. sp.

Type. Length 58 mm., to base of caudal 47; depth 9 mm., width 5½; D. 8, A. 9; scales 5 or 6—38 to 40—4; dorsal region clear ferruginous, with a fine dusky band; a rather broad lateral silvery band; scales of lateral line with little dark spots, as in *N. telescopus;* fins yellowish-white, no spot on dorsal or caudal; front of dorsal to base of caudal 24 mm., to end of snout 23; dorsal fin beginning a little *anterior* to level of pelvic; region before dorsal not bare of scales. Scales with 9 apical radii.

This was supposed to be *N. piptolepis* (Cope) or *N. gilberti* Jordan & Meek, these two names being considered by Drs. Evermann and Kendall probably synonymous. At the U. S. National Museum I found the type of *N. gilberti,* which proves to be very distinct, as follows:

1. *N. gilberti,* type. Diameter of eye 3.9 mm., snout beyond eye 3; depth of head 7.35 mm.; snout to base of caudal 39; beginning of dorsal level with beginning of ventral; no dark dorsal band; ventral scales exceedingly broad.

2. *N. horatii,* type. Diameter of eye 3, snout beyond eye 3.4; depth of head 6.35 mm.; snout to base of caudal 45.5; beginning of dorsal in front of beginning of ventral; a dark dorsal band; ventral scales ordinary.

Both have a silvery lateral band; the dorsal area of *gilberti* is darker and redder. The dorsal profile of head and anterior part of body in *horatii* is practically flat. The corners of the mouth in *horatii* are a little anterior to the level of front of eye.

The question now arises whether the fish can be *N. piptolepis,* to which it runs in my table of Colorado Cyprinidæ (Univ. of Colo. Studies, Vol. V., No. 3). The type of *piptolepis* seems to be lost, as it was not found at the National Museum, and Fowler does not list it in his account of the species in the collection at Philadelphia. Possibly the name may have to be given up as undeterminable, but we have a mason-jar full of a species collected in Boulder Creek by Juday, recorded by him as *piptolepis* and accepted as such by me. This fish is certainly quite distinct from *horatii,* and I believe it to be Cope's species. Although *N. horatii* is doubtless of the immediate alliance of *piptolepis* and *gilberti,* it is superficially very like *N. stilbius* and *N. telescopus,* in another group. The species is

named after Mr. Horace G. Smith, of Denver, who has long studied the fauna of Colorado, and who went to great trouble to revisit the locality and obtain additional material. The other Cyprinids found by Mr. Smith at Julesburg were *Semotilus atromaculatus macrocephalus* (Girard) and *Phenacobius scopifer* (Cope).

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A BACTERIAL GUMMOSIS OF CHERRIES

CERTAIN varieties of the cultivated sweet cherries grown in the Pacific northwest are very subject to a diseased condition which is commonly known as "cherry gummosis." The disease is characterized by more or less copious exudation of gum from the trunk, branches, spurs and buds as well as by a pustulated appearance of the bark near the diseased areas. Often but little gum is exuded, but in such cases an examination of the affected trees generally discloses discolored tissues which is infiltrated with gum. Such areas are spongy to the touch and are usually discernible by the variation in color of the bark as compared with that of the normal.

Gummosis is found in every cherry growing section of Oregon, but it is in the more humid portion of western Oregon that its prevalence and destructiveness gives it the rank of a major disease, and where its appearance in an orchard is most dreaded by the grower.

Cherry gummosis appeared soon after the first planting of cherries in the state. Its prevalence has varied from season to season, being apparently more abundant in those years when the trees experienced rather sudden extreme variations in temperature after growth had started. This has led observing growers to attribute the trouble chiefly to the climatic factor. The disease appears on a wide range of soil, but the trees growing in the more exposed locations or on poorly drained or shallow soil are generally the worst affected.

Cherry gummosis appears in both a localized and generalized form. In the former, the disease is apparently confined to rather limited areas on the trunk or branches, such areas being most often associated with a blighted spur or bud. In the generalized form, large areas of the trunk or branch may become involved, and it often results in complete girdling. This latter type of gummosis often appears to originate in the crotch of the tree.

The writer was assigned the problem of investigating the possible causes and prevention of cherry gummosis while a student in the Oregon Agricultural College. In the spring of 1909, I noted bacteria in sections of blighted cherry fruit spurs, and upon making cultures from fresh material, found the organisms to be rather constantly associated with such diseased spurs. I had to drop the investigation for the time being on account of the stress of other work, but from the few direct inoculations made into healthy spurs a blighting or gumming occurred.

In the spring of 1910 a large number of cultures were made from material procured in different cherry-growing sections. In the agar plates resulting from such cultures, one type of organism seemed to predominate, and it often appeared in pure culture. From pure cultures thus obtained a series of inoculation experiments were made in which the organisms were transferred from agar slants to healthy fruit spurs by needle pricks. The spurs thus inoculated, blighted or gummed. while the checks healed without blighting or gumming. The typical organism was re-isolated from the inoculated spurs and again inoculated into other healthy fruit spurs. These inoculated spurs again blighted and gummed while the checks remained normal.

During the present season the work has been continued, and several series of inoculations have been made with different strains of the organism. As a result of these inoculations and reinoculations in which I have tried to follow implicitly the Rules of Proof of Pathogenicity as found in Smith's "Bacteria in Relation to Plant Diseases," I believe I have found a specific cause of at least one form of cherry gummosis.

In the two other cases where I have seen bacteria reported as being associated with gummosis of the cherry, the first, that reported by Brzezinski[1] contained very little information concerning the morphological and cultural characteristics of the organism and all attempts at a comparison of Brzezinski's and my organism were abandoned. In the second instance, that reported by Aderhold and Ruhland,[2] more detailed information was given and I have tried to determine the relationships of the two organisms. The morphology of *Bacillus spongiosus*[2] resembles that of my organism very closely. A difference, however, has been noted in certain of the cultural features. I have not been able to obtain the "vacuolated" or "spongy" appearing colonies in agar or gelatin containing grape sugar, a feature which Aderhold and Ruhland regarded as important, and upon which they based the specific name of their organism. In addition, a chromagenic feature appears when my organism is grown on certain media, namely a greening of the agar in plates, stabs, and slants; in gelatin plates and stabs which are liquefied as well as in old broth cultures, a feature which is not attributed to *B. spongiosus.*

I would have preferred to do at least another year's work before publishing the cultural characteristics and describing my organism as a new species. However, as I have severed my connections with the investigation, I feel it necessary to at least tentatively describe and name my organism as follows:

Pseudomonas cerasus n. sp., an actively, motile, rod-shaped schizomycete, bearing one or two polar flagella, 1.5μ to 2.5μ long, and from $.5\mu$ to $.8\mu$ in diameter. The rods are usually found in pairs and no long chains have been noted. Spores have not been observed and cultures heated at 80° C. for 15 minutes are killed. The organism stains readily with the common stains, is Gram negative and is not acid fast. It grows on all the ordinary cultural media mentioned in the Society's Descriptive Chart excepting Cohn's solution and silicate jelly. It did not form gas in any of the media tried and it prefers an acid medium to one alkaline. The group number is Ps. 211.2322433.

The manner of infection and method of prevention is yet to be worked out. Ordinarily the fruit spur blight is not serious or abundant enough to justify cutting out, but if the generalized form of gummosis should prove to be of a similar specific origin, systematic cutting out, sterilizing of the wounds and burning of the diseased cuttings would be necessary.

Cherry trees weakened through gummosis fall easy prey to various saprophytic fungi, *Schizophyllum commune, Polyporus* sp. and *Polystictus* sp. being the most common. One of the imperfect fungi, which appears very frequently in the gummosis cankers, but whose identity has not been fully determined, may prove to be at least semi-parasitic in nature.

The growers have found by experience that top working resistant stocks will to a great extent prevent the disease from appearing on the body, or crotch of the tree. The Mazzard seedling is most often used for this purpose although the Morello, Duke and a native western cherry have been successfully utilized. The method is to plant the seedling in the orchard in the usual manner and then top work the branches, preferably by budding at least twelve inches above the crotch, when the trees are two or three years old. This eliminates the gummosis factor from the trunk and crotch, but the disease may later affect the fruit-bearing wood.

The Royal Ann, Bing and Lambert, which are the principal commercial varieties, are all susceptible to gummosis; the Lambert being the most resistant.

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[1] Brzezinski, P. J., "Etiologie du chancre et de la gomme des arbres fruitiers," *Comptes Rendus*, 134 (1902), No. 20, pp. 1170–73.

[2] Aderhold and Ruhland, "Ueber der Bakterienbrand der kirchbaume," Fl. No. 39 der Kaiserl. Biolog. Anstalt. für land- und Forstw., Berlin, 1906.

SCIENCE

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THE RELATION OF THE LABORATORY TO MEDICINE[1]

In addressing so representative a body as this association I can not but feel that I am engaged almost in a work of supererogation when I presume to speak upon a topic so familiar to you all. Despite this feeling on my part, I am led to believe that upon occasion an oft-told tale, if palatably redressed, may prove appetizing enough: I will venture an experiment.

A careful perusal of the pages of the history of medicine plainly demonstrates the long and tortuous path pursued from the ages of earliest record down to relatively recent times. We can see how at one time the noble art was held in the clutches of superstition, its acts governed by a deep-rooted primal belief in demonology; at another time religious doctrines dominated and intimidated progress; and at other periods metaphysical discussions held back advance and even wrecked discoveries. The history of this struggle onwards towards the light of knowledge, marked as it has been by errors and lapses, is fascinatingly punctuated by epoch-making contributions here and there along the line by an occasional genius or hard-headed thinker. It is not to be doubted, however, that had it not been for the wonderful development of the sciences, the modern status of medicine would have been held back for an indefinite period. Our debt to the pioneers in chemistry, physics and biology, and to their successors down to the present moment, is enormous, and we must

[1] Read at the thirtieth annual meeting of the Ontario Medical Association, Niagara Falls, Ontario, May 30 to June 1, 1911.

realize that instead of holding aloof from, medicine actually shares in or belongs to all of the sciences.

The development of the laboratory and its final establishment as an aid in the furtherance of medical teaching and study has been so ably presented by such an eminent authority as Professor William H. Welch in his address on the "Evolution of Modern Scientific Laboratories," that I will not attempt the foolish task of "gilding gold"; but I need only emphasize how the invaluable researches of such as Harvey, Magendie, Hunter, Bichat, Laennec, Claude Bernard, Virchow, Pasteur and Koch paved the way for the founding of institutions where ideas might be tested, problems solved and enquiring minds trained.

What a powerful stimulus, emanating from such places, has medicine received in these latter days! In fact, the laboratory constitutes the very foundation upon which medicine of to-day rests; it is the very powerful lever resting upon the fulcrum of ascertained facts that has elevated medicine from the dust of empiricism to the cloud-level of science, along which runs a road, perhaps none the less rough and long, to a goal of ultimate success.

At this point I may seem to some of you to be carried away with the greatness of the importance of the science of the laboratory at the expense of the practise of medicine. I am not. I am conscious of the great importance of both sides of medical advance and teaching. I think that we scarcely yet realize the extent of the tremendous revolution in medical thought and practise the laboratory has introduced; we are yet involved in the process, and although some of us feel that in the training of students far too much time is expended in laboratory work, profitless it may in part appear, and too little time spent in preparation for practise, I do not doubt but that proper adjustment will come about when the evolution in progress becomes clearer to us.

Turning now to a more critical analysis of the relation of the laboratory to medicine, I will attempt to put before you in concrete fashion what I believe to be its chief functions.

In the first instance, the laboratory occupies the very fundamental position of being the place, *par excellence,* of the inductive method of impartation of knowledge; in the second, it is or ought to be the place of sound mental training and of cultivation of powers of observation; in the third, it represents applied science, and in the fourth instance it is the place of research and experiment.

Taking these up seriatim: I. Gone forever are the days of medical instruction wherein the didactic lecture played the entire rôle as the imparter of knowledge in the medical school! The lecture, will, of course, continue to hold a place in the curriculum of studies, but not so lofty or important a one as in pre-laboratory days —it has now almost assumed the humble duties of handmaid to the laboratory course, particularly in these instances where the textbook in use in a class has developed out of the yearly lectures of the head of the department.

As a place of instruction the work of the laboratory in a department requires delicate adjustment to the medical courses. I do not now propose to enter into a discussion of the relative numbers of hours to be assigned to lectures and laboratory work, nor of the time to be given to one subject of instruction relative to that of other subjects in the curriculum; at the present juncture they are irrelevant though interesting questions. Taking into consideration as granted that a laboratory is well manned and equipped, the courses should

be planned to conform to the best usage of university standards of instruction. An ample range of instruction should be afforded both in routine work, advanced work and research—all under the immediate supervision of either the head of the department or of one or other competent assistant.

In the medical courses, to properly assign and regulate the advanced work and research is sometimes a matter of no small difficulty. The number of properly qualified students, their mental caliber, their fitness for certain lines of work, the time at their disposal, are some of the many points that have to be taken into consideration in establishing and carrying on such courses. Of the two, that of advanced work is the more easily susceptible of solution. Courses may be designed throughout the year wherein work may be assigned, for a few hours a week, say five, and the nature of the topic may be so planned as to throw the student in part upon his own resources and thus encourage in him a necessary initiative. In this work the instructor can also train the student in the best ways to gain access to the literature of the subject in hand, and even demand of him a short thesis. By a properly balanced plan for advanced work we can foster a spirit for research, and perhaps gain a recruit for a task of serious investigation.

Within the limits of our ordinarily organized four-year course in medicine it seems to me to be an almost hopeless task to carry through successfully a piece of work worthy the name of research, even with our most promising students. The curriculum is so crowded and the routine so oppressive that they impose both a mental and a physical strain upon the individual, no matter how full of enthusiasm he be, that attempting research under such conditions seems unjustifiable and indefensible.

True, research among our students should be encouraged, but let it be inaugurated at the termination of the periods of either the scientific or clinical courses, when the burden of routine may be abolished or mitigated for nine months or a year or two. If such a plan were carried out, a better choice could be made of candidates upon the basis of fitness, and would lead to the performance of investigation of a sound and creditable character, not masquerading under the name "research." By the encouragement of properly conducted research we may also be able to develop men and conserve their services at a later date for scientific pursuit and teaching instead of losing them in the alluring field of active practise. For I would have you remember that the future will make even greater demands upon us than has the past for suitable assistants and worthier successors in the fundamental branches of our profession.

II. For affording a sound mental training and for cultivating the powers of observation among a body of students, it goes without saying that the laboratory must be officered by capable persons, who, in addition to being well versed in their subject, ought to be selected also for their ability to impart knowledge. Examples can be recalled by most of us when as students we sat under men noted for their erudition but displaying an alarming innocence of even moderate pedagogical ability, which to some may have proved a stumbling-block to progress and implanted in us perhaps a veritable dislike for our studies. Or classes may be handled by instructors who are "unfaithful servants," regarding the students collectively as an intolerable burden, feeling that their duty is done if

they dispense knowledge after the manner of the "quick-lunch" counter.

On the contrary, no better reward can come to the conscientious instructor than in the very apparent, although verbally unexpressed, appreciativeness on the part of the class of his efforts to give the best that is in him. This success may be attained by giving the greatest amount of personal attention to the class as individuals, combined with general criticism, demonstration and sharp questioning concerning the occurrence of phenomena in the course of close objective study. It is quite remarkable how frequently a class of seeming mediocrity may be spurred on to good and reasonable endeavor by carefully applied methods for stimulating mental processes and awakening latent powers of observation. This leads usually to a development of a healthy independence of mind which is far removed from that mental type that is content with a senseless cramming-up of oftentimes dissociated bookish statements of facts.

Of the utmost importance is the attainment of that open manifestation in the student body of the fruits of a careful laboratory training upon entrance on the clinical period of study. For then it is that the ready aid of an alert and reasoning mind and a keen power of observation is so necessary to the student, if he is to successfully solve the thousand and one enigmas to be met daily in the dispensary classes and ward rounds. The effects of a training such as has been described are destined to last him throughout his career either as an investigator or a practising physician.

There may be some present who will be inclined to disagree with me on this statement; who already feel that our students are so crammed full of "science" that the laboratory training unfits them for acquiring a due appreciation of clinical viewpoints and methods. In fact, I have heard it time and again expressed, "We don't want to turn out scientists, but practitioners of medicine!" Then, in Heaven's name, O clinicians, go to, turn our youthful so-called scientists into practitioners! The matter of so doing lies in your hands, not ours! To fail is to proclaim your own inefficiency as teachers. For I can assure you, out of an experience of some length of service, that the bulk of student material is to-day not worse than formerly, but better; more alert, more discriminating and more enquiring. He who would be their teacher must himself arise with the lark!

Another point redounding to the credit of careful laboratory instruction ought to be mentioned here. By the very processes used to develop mentally robust students, those to whom nature with niggard bounty has allotted the amount or quality of nervous gray-matter are with sureness eliminated from the race.

I maintain then that the laboratory justifies most thoroughly the high place it now occupies in the teaching of medicine, not merely from the fact that it is one of the great dispensators of knowledge, but largely because, if wisely conducted, it is the strongest of developmental forces in the successful making of future disciples of Æsculapius.

III. It is almost needless for me to lay emphasis on the importance of the laboratory as the place of applied science—I need only mention the daily use in hospital service of the microscope, polariscope, the X-ray, radium emanations, the many clinical, bacteriological and biological tests, and at times even the procedure of the physiologist, to prove the value of the laboratory as an indispensable adjunct to the practise of clinical medicine.

This appreciation of practical science is again shown in the establishment by city,

provincial and state authorities of laboratories more or less well-equipped for aiding the busy practitioner in his problems of service to his patients. Private laboratories for the same purpose exist in many places, where for reasonable remuneration all sorts of tests and examinations are carried out. In not a few instances men with large practises employ in their offices of consultation skillful persons, usually recent graduates, who render prompt and efficient service in clinical diagnosis.

IV. As a place of experiment and research, I feel that in the highest degree the laboratory more than justifies its existence. It constitutes the great testing-shop of ideas and theories, either generated within its walls as the result perhaps of previous experiment, or of those coming to it from beyond, the results of which may at once be made available for application in the clinical field.

As previously pointed out, medicine is no longer confined within narrow bounds, but constitutes a field of activity so wide as to demand the assistance of the other sciences to help solve its problems. And realizing full well that in this day and generation of progress in knowledge no one man is capable of becoming an expert in all of the sciences, we are in consequence witnessing medical research develop in complex form; where laboratories are established for research in physiology, pathology, chemistry, sanitary science and the like—attached to or entirely apart from the organization of medical school or university.

And so profoundly has the development of the laboratory in late years affected the course of medicine abroad, particularly in Germany, that that "holy of holies" of the clinicians, the hospital ward, is regarded as a laboratory of research, as it essentially is and properly should be. There the professor of medicine and his chief assistants are both excellent clinicians and excellent laboratory workers; their duties to the hospital markedly limit or abolish private practise and leave ample time for carrying out instruction and research. In the United States the same development has begun; witness the establishment of the hospital in connection with the Rockefeller Institute for Medical Research, where diseases of all sorts may be intensively studied by combined clinical and scientific methods, the right of remunerative practise being denied the staff. At the present moment, too, the authorities of the Johns Hopkins University, appreciating the great value of this movement in modern medicine, are formulating plans whereby the heads of all the clinical branches be denied the right of private practise and be required to confine their whole attention to the development of ward material for purposes of instruction and research.

Reading then the signs of the times correctly, it appears that medicine has now entered upon a new and profitable era; upon a period of development wherein the scientific or laboratory idea is effecting a cleavage in the clinical field both in its methods and in its personnel. Revolutionary as it may now seem, the clinical branches in our teaching institutions in the future will probably be most largely filled by those who are at the same time competent clinicians and carefully trained workers in one or other line of scientific research, devoting most of their time to instruction and investigation and less or none to the distractions of private practise.

At this juncture I do not wish to be adjudged as one who is engaged in belittling the efforts of the clinical professor, past or present; that would be wickedly unjust, but I do believe that the time has come when not to acknowledge this evolutionary trend in clinical medicine is to

deny rational progress towards the solution of the innumerable and weighty problems confronting us.

Let me say in conclusion that it is my firm belief that in the untrammeled concentrated study of the phenomena of disease, with the ward as the laboratory, will medicine become truly scientific (in the best sense of that word), therefore truly rational, with hopes of conquest its best endeavor and success its ultimate goal. The change will evolve a man better taught, better trained and possibly possessed of better judgment. The numbers of those who practise or pursue the "art" of medicine will yet increase and reap larger and more abundant rewards in satisfaction of work well done than has hitherto been dreamed of. For the new era will demand the survival of the fittest to survive, and the practise of the profession of medicine will in even greater degree be counted the most honorable of all professions.

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THEORIES OF SOLUTIONS[1]

TWENTY-ONE years ago the Chemistry Section of the British Association at its meeting in Leeds was the scene of a great discussion on the nature of solutions. It was my first experience of a British Association meeting, and I well remember the stimulating effect of the lively discussion on all who took part in it. To-day, speaking from the honorable position of president of the section, I conceive I can do no better than indicate the position of the question at the present time. And this appears to me the more appropriate as our science has had this year to mourn the departure of van't Hoff, the founder of the modern theory of solution, whose name will remain one of the greatest in theoretical chemistry—in time to come, it will, I think, be considered almost the greatest. He had expressed the hope that he might attend this meeting as he did that twenty-one years ago. The hope is not fulfilled: his activity is merged in the final equilibrium of death. But his ideas are part and parcel of the chemical equipment of every one of us, and we know that whatever form the fundamental conceptions of chemistry may assume, the quantitative idea of osmotic pressure will be to the theory of solution what the quantitative idea of the atom is to chemical composition and properties. For I must emphasize the fact that chemistry is essentially a quantitative science, and no chemical theory, no partial chemical theory even, can be successful unless its character is quantitative. To quote the words of Lord Kelvin:

> I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you can not measure it, when you can not express it in numbers, your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the stage of science.

A general theory of solutions must be applicable to all solutions—to those in which solvent and solute exist in practically mere intermixture, as well to those in which solute and solvent are bound together in what we can not sharply distinguish from ordinary chemical union. Between these extremes all grades of binding between solvent and solute exist, and it may be well to give a few examples illustrating the various types of solution.

Where no affinity exists between solvent and solute, the solution is practically of the same type as a mixture of two gases which are without chemical action on each other. The solute is merely diluted by the solvent

[1] Address of the president of the Chemical Section of the British Association for the Advancement of Science. Portsmouth, 1911.

and retains its properties unchanged. An example of this type of solution may be found in the solution of one saturated hydrocarbon in another, say of pentane in hexane. On mixing the two liquids there is no evidence of union between them, the volume of the mixture is practically the sum of the volume of the components, the heat of solution is practically *nil*, the vapor pressure of each constituent is reduced merely as if by dilution with the other constituent, and so on. That there is some action between the two components even in this extreme case must be admitted, but it may be referred entirely to action of a physical kind, such as one finds on mixing one gas with another at considerable pressures. Action of a chemical nature is absent. If it be said that even saturated hydrocarbons have some chemical affinity for each other, recourse may still be had for examples to mixtures of two inactive elements, say liquid argon and liquid krypton, where chemical affinity is non-existent.

At the other extreme we have such solutions as those of sulphuric acid and water. Here there is every physical evidence of chemical union. The volume of the mixture is by no means the sum of the volumes of the components, the amount of heat evolved on mixing is very great, the separate liquids, which are practically non-conductors, yield on mixing a solution which is a good conductor, and so on. There is obviously here a great influence of the solvent water on the solute sulphuric acid, and this influence we can only account for by assuming that it is essentially chemical in character.

As the influence in such a case is necessarily reciprocal, then if even one of the constituents of the solution is inactive chemically there can plainly be no action of a chemical nature on mixing. Thus, no matter what solvent we take, it can exercise no action other than that of a physical kind on argon, say, which has been dissolved in it; and, again, if liquid argon is chosen as solvent no substance dissolved in it can be affected by it chemically, and we thus obtain only the properties of a physical mixture. It is convenient therefore to classify liquid solvents according to their chemical activity. The saturated hydrocarbons, which are chemically very inert, and, as their name paraffin implies, little disposed to chemical action of any kind, may be taken as typically inactive solvents, analogous to liquid argon. Water, on the other hand, as its numerous compounds (hydrates) with all kinds of substances testify, may be taken as a typically active solvent. The ordinary organic solvents exhibit intermediate degrees of activity.

For the purpose of illustrating the effect of solvents on a dissolved substance one may conveniently take a colored substance in a series of colorless solvents. If the substance is unaffected by the solvent, we might reasonably expect the color of the solution to be the same as the color of the vapor of the substance at equal concentration. Iodine, for instance, gives rise to the familiar violet vapor. Its solution in carbon disulphide has a color practically similar, but its solution in alcohol or water is of a brown tint quite different from the other. In the indifferent hydrocarbons and in chloroform the color is like that in carbon disulphide, in methyl or ethyl alcohol it is brown. We conclude therefore roughly that iodine dissolved in saturated hydrocarbons, in chloroform, carbon tetrachloride and carbon disulphide is little affected by the solvent, whereas in water and the alcohols it is greatly affected, probably by way of combination, since in all the solvents two atoms of iodine seem to be associated in the molecule. That combination between the iodine and the active solvents has really

occurred receives confirmation from the behavior of iodine in dilute solution in glacial acetic acid. If the color of this solution is observed in the cold it is seen to be brown, resembling in color the aqueous solution. If the solution be now heated to the boiling-point, the color changes to pink, which may be taken to indicate that the compound of iodine and acetic acid which is stable at the ordinary temperature becomes to a large extent dissociated at 100°.

Now, as I have said, a general theory of solution must be applicable to all classes of solution, and herein lies the importance of van't Hoff's osmotic pressure theory. It applies equally to mixtures of gases, to mixtures of inert liquids, and to mixtures such as those of sulphuric acid and water; and it has the further advantage that so long as the solutions considered are dilute there are simple relations connecting the osmotic pressure with other easily measurable properties of the solutions. It has been unfortunately the custom to oppose the osmotic pressure theory of solution to the hydrate, or more generally the solvate, theory, in which combination between solute and solvent is assumed. The solvate theory is, in the first place, not a general theory, and in the second place it is perfectly compatible with the osmotic pressure theory. It is in fact with regard to a general theory of solutions on the same plane as the electrolytic dissociation theory of Arrhenius. This theory of ionization applies to a certain class of solutions, those, namely, which conduct electricity, and is a welcome and necessary adjunct in accounting for the numerical values of the osmotic pressure found in such solutions. Similarly the hydrate, or more generally the solvate, theory is applicable only to those solutions in which combination between solvent and solute occurs, and will no doubt in time afford valuable information with regard to the osmotic pressure, especially of concentrated solutions in which the affinity between solvent and solute is most evident. It can tell us nothing about solutions in which one, or both, components is inactive, just as the electrolytic dissociation theory can tell us nothing about solutions which do not conduct electricity.

The great practical advantage bequeathed to chemists by the genius of van't Hoff is the assimilation of substances in dilute solution to substances in the gaseous state. Here all substances obey the same physical laws, and a secure basis is offered for calculation connecting measurable physical magnitudes, irrespective of the chemical nature of the substances and of the solvents in which they are dissolved, provided only that the solutions are non-electrolytes. If the solutions are electrolytes, the dissociation theory of Arrhenius, developed independently of the osmotic pressure theory of van't Hoff, gives the necessary complement, and for aqueous solutions offers a simple basis for calculation. Van't Hoff has given to science the numerically definable conception of osmotic pressure; Arrhenius has contributed the numerically definable conception of coefficient of activity of electrolytes in aqueous solution, or what is now called the degree of ionization.

Of late there has been a tendency in some thermodynamical quarters to belittle the importance of the conception of osmotic pressure. It is quite true that from the mathematical thermodynamical point of view it may be relegated to a second place, and even dispensed with altogether, for it is thermodynamically related to other magnitudes which can be substituted for it. But it may be questioned if without the conception the cultivators of the thermodynamic method would ever have arrived at the results obtained by van't Hoff through osmotic pressure. Van't Hoff was

only an amateur of thermodynamics, but the results achieved by him in that field are of lasting importance, and his work and the conception of osmotic pressure have given a great stimulus to the cultivation of thermodynamics to chemistry.

And here we trench on a question on which a certain confusion of thought often exists. To the investigator it is open to choose that one of several equivalent methods or conceptions which best suits his personal idiosyncrasy. To the teacher such a choice is not open. He must choose the method or conception which is most clearly intelligible to students, and is at the same time least likely to lead to misconception. Osmotic pressure is a conception which the chemical student of mediocre mathematical attainments can grasp, and it is not difficult to teach the general elementary theory of dilute solutions by means of it and of reversible cycles without liability to radical error or misconception. I should be sorry on the other hand to try to teach the theory of solutions to ordinary chemical students by means of any thermodynamic function. The two methods are thermodynamically equivalent, and the second is mathematically more elegant and in a way simpler, but it affords less opportunity than the first for the student to submit his methods to any practical check or test, and in nine cases out of ten would lead to error and confusion. The difficulty of the student is not the mathematical one; with the excellent teaching of mathematics now afforded to students of physics and chemistry the mathematical difficulty has practically disappeared—the difficulty lies in critically scrutinizing the conditions under which each equation used is applicable.

Of the mechanism of osmotic pressure we still know nothing, but with the practical measurement of osmotic pressure great advances have been made in recent years. In particular the admirable work of Morse and Frazer is of the first importance in establishing for solutions up to normal concentration the relationship between osmotic pressure and composition, and its variation with the temperature. Much may be anticipated from the continuation of these accurate and valuable researches, the experimental difficulties of which are enormous.

We are indebted to America not only for these researches, and for the voluminous material of H. C. Jones and his collaborators dealing with hydrates in solution, but also to A. A. Noyes and his school for accurate experimental work and for systematic treatment of solutions on the theoretical side. They, and also van Laar, have shown how solutions not coming within the ordinary range of dilute solutions to which van't Hoff's simple law is applicable, may in some cases at least be made amenable to mathematical treatment. Van't Hoff chose one simplification of the general theory by considering only very dilute solutions, for which very simple laws hold good, just as they do for dilute gases. Even a single gas in the concentrated or compressed form diverges widely from the simple gas laws; much more then may concentrated solutions diverge from the simple osmotic pressure law. The other simplification is to consider solutions of which the components are miscible in all proportions and are without action on each other; and this method has been developed with marked success from the point of view of osmotic pressure and other colligative properties.

The outstanding practical problem in the domain of electrolytic solutions is to show why the strong electrolytes are not subservient to the same laws as govern weak electrolytes. If we apply the general mass-action law of chemistry to the electrically active and inactive parts of a dissolved substance

(the ions and un-ionized molecules) as deduced from the conductivities by the rule of Arrhenius, we find that for a binary substance a certain formula connecting concentration and ionization should be followed, a formula which we know by the name of Ostwald's dilution law. This law seems to be strictly applicable to solutions of feeble electrolytes, but to solutions of strong electrolytes it is altogether without application. Wherein lies the fundamental difference between these two classes of solutions? Two kinds of explanation may be put forward. First, the ionized proportion may not be given accurately for strong electrolytes by the rule of Arrhenius; or second, the strong electrolytes do not obey the otherwise general law of active mass, which states that the activity of a substance is proportional to its concentration. The first mode of explanation has been practically abandoned, for other methods of determining ionization give values for strong electrolytes in sufficient agreement with the values obtained by the method of Arrhenius. The other explanation is that for some reason the law of active mass is, apparently or in reality, not obeyed by some or all of the substances in a solution of a strong electrolyte. An apparent disobedience to the law of mass-action would, for example, be caused by the formation of complexes such as Na_2Cl_2, or Na_2Cl^+ or $NaCl_2^-$ in a solution of sodium chloride. Mere hydration, *e. g.*, the formation of a complex $NaCl_1$ 2 H_2O, would not affect the mass-action law in dilute solution, and the electrolyte would obey the dilution law in solutions of the concentration usually considered. A somewhat similar explanation, which takes into account the properties of the solvent, is that the ionizing power of the solvent water undergoes a noticeable change when the concentration of the ions in it increases beyond a certain limit.

I should wish now to draw attention to a point of view which has not, so far as I am aware, been fully considered. To begin with we may put to ourselves the question: Is it the ions in the solution which are abnormal or is it the non-ionized substance? A simple consideration would point at once to it being the non-ionized portion. We have, for example, in acetic acid a substance which behaves normally, so that the ions H^+ and Ac^- as well as the undissociated molecule HAc are normal. Similarly in ammonium hydroxide the ions NH_4^+ and OH^- as well as the non-ionized NH_3 and NH_4OH all behave normally. When we mix the two solutions there is produced a substance, ammonium acetate, which behaves abnormally. Now, on the assumption that the equilibrium we are now dealing with is

$$NH_4^+ + Ac^- \rightleftarrows NH_4Ac,$$

which of these molecular species is abnormal in the relation between its concentration and its activity? Probably not the ions NH_4^+ and Ac^-, because these were found to act normally in the solutions of acetic acid and ammonia. The presumption is rather that the abnormal substance is the undissociated ammonium acetate, for this occurs only in the abnormal acetate solution, and not in the normal acetic acid and ammonia. This view, that it is the non-ionized portion of the electrolyte which exhibits abnormal behavior, and not the ions, has been reached on other grounds by Noyes and others, and I hope in what follows to deduce reasons in its support.

One is apt, because the ions are in general the active constituents of an electrolyte, to lay too much stress on their behavior in considering the equilibrium in an electrolytic solution. We are justified in attributing the fact that acetic acid is a weak acid, whilst trichloracetic acid is a powerful one, rather to the properties of

the un-ionized substances than to the properties of the ions. The divergence of trichloracetic acid from the simple dilution law may similarly be due to an inherent property of the un-ionized acid, a single cause being not improbably at the bottom of both the great tendency to split into ions in water and also the abnormal behavior towards dilution.

However that may be, I think the following reasoning goes far to show that the non-ionized portion of the electrolyte is that which is primarily abnormal in its behavior, the ions acting in every way as normal. The dilution formulæ of Ostwald or of van't Hoff are essentially equilibrium formulæ. One side of the equilibrium represents the interaction of the ions to form the non-ionized substance, the other side represents the splitting up of the non-ionized substance into ions. In order to fix our ideas, we may consider a salt which obeys the empirical dilution-formula of van't Hoff. If c_u represents the molar concentration of the un-ionized portion, and c_i the molar concentration of each ion, then according to van't Hoff's empirical formula,

$$\frac{c_i^3}{c_u^2} = \text{const.}$$

If the law of mass-action were obeyed we should have, on the other hand, Ostwald's dilution formula,

$$\frac{c_i^2}{c_u} = \text{const.}$$

According to this last formula, the activity of each substance concerned varies directly as its molar concentration, and a normal result is obtained on dilution. According to van't Hoff's formula as stated above, the activity of none of the substances concerned varies directly as its concentration; but since the constancy of the expression is the only test of its accuracy, there are obviously other methods of stating the relation which will throw the abnormal behavior either on the ions or on the non-ionized substance. Thus, if we write the equivalent form

$$\sqrt{\frac{c_i^3}{c_u^2}} = \text{const., or } \frac{c_i^{1.5}}{c_u} = \text{const.,}$$

the un-ionized substance is here represented as behaving normally, and the ions abnormally; whilst if we write the formula in the form

$$\frac{c_i^2}{c_u^{1.33}} = \text{const.,}$$

the ions are represented as behaving normally, and the non-ionized substance abnormally. Now it is very important that a choice should be made amongst these three expressions, all equivalent amongst themselves so far as the mere constancy of the expression is concerned, as tested by measurements of electrolytic conductivity. Looked at from the kinetic point of view we have in the first form,

$$\frac{dx}{dt} = kc_i^3$$
$$-\frac{dx}{dt} = k'c_u^2,$$

both direct and reverse actions abnormal. In the second form, we have

$$\frac{dx}{dt} = kc_i^{1.5}$$
$$-\frac{dx}{dt} = k'c_u,$$

the ionization being normal, the recombination abnormal. And in the third form we have

$$\frac{d}{dt} = kc_i^2$$
$$-\frac{dx}{dt} k'c_u^{1.33},$$

the ionization being abnormal and the recombination normal.

Now, if it were possible to measure directly the velocity of either ionization or recombination, we should at once be able to select the equilibrium formula which was

really applicable. Unfortunately such velocities are so high as to be beyond our powers of measurement. Yet it seems possible to seek and obtain an answer from reaction velocities which are measurable. One assumption must be made, but it seems to me so inherently probable that few will hesitate to make it. It is this: if a substance in a given solution has normal activity with respect to one reaction, it has normal activity with respect to all reactions in which it can take part in that given solution. Similarly, if a substance in a given solution exhibits abnormal activity with respect to one reaction, it will exhibit abnormal activity with respect to all.

Granting this assumption, we have then to find a reaction in which either the ionized or un-ionized portion of an abnormal electrolyte is converted into a third substance with measurable velocity. Such a reaction exists in the transformation of ammonium cyanate into urea in aqueous and aqueous-alcoholic solutions, which was investigated some years ago by myself and my collaborators, and found to proceed at rates which could easily be followed experimentally. First of all comes the question: Is the urea formed directly from the ions or from the un-ionized cyanate? As Wegscheider pointed out, it is impossible from reaction-velocity alone to determine which portion passes directly into urea, if the velocities of ionization and recombination are infinitely greater than that of the urea-formation, as is undoubtedly the case. Other circumstances make it highly probable that the ions are the active participants in the transformation, but we may leave the question open, and discuss the results on both assumptions.

Suppose, first, that the un-ionized cyanate is transformed directly into urea. Then we have the successive reactions

$$NH_4^{\cdot} + CNO' \rightleftarrows NH_4CNO \rightarrow CO(NH_2)_2.$$

The slight reverse transformation of urea into cyanate may for the present purpose be neglected, as it in no way influences the reasoning to be employed.

If the un-ionized substance behaves normally, then the conversion of the ammonium cyanate into urea, when referred to the un-ionized substance, will appear unimolecular and obey the law of mass-action: when referred to the ionized substance it will not appear to be bimolecular and will not obey the law of mass-action.

Suppose, now, that the direct formation of the urea is from the ions. Then we are dealing with the actions

$$NH_4CNO \rightleftarrows NH_4^{\cdot} + CNO' \rightarrow CO(NH_2)_2.$$

Again, let us assume the un-ionized substance to be normal. Once more, if the transformation is referred to the non-ionized substance it will appear as monomolecular; when referred to the ionized substance it will not appear as bimolecular, as it should if the mass-action law were obeyed.

It is a matter of indifference, then, so far as the point with which we are dealing is concerned, whether the ionized or the non-ionized cyanate is transformed directly into urea. If the non-ionized cyanate behaves normally the action when referred to it will in either case appear to be strictly monomolecular.

If the ionized cyanate, on the other hand, behaves normally, the reaction when referred to it will be bimolecular and normal; when referred to the non-ionized cyanate it will not be monomolecular, and therefore will be abnormal.

The actual experiments show that whether water or a mixture of water and alcohol be taken as solvent, the reaction when referred to the ions is strictly bimolecular; when referred to the non-ionized substance it is not monomolecular, *i. e.*,

proportional to c_u, but rather proportional to a power of c_u other than the first, namely, $c_u^{-1.4}$.

This is, to my mind, a very strong piece of evidence that in the case of the abnormal electrolyte, ammonium cyanate, the abnormality of the ionization equilibrium is to be attributed entirely to the non-ionized portion. But ammonium cyanate differs in no respect, with regard to its electrolytic conductivity, from the hundreds of other abnormal binary electrolytes with univalent ions; and I am therefore disposed to conclude that it is to the non-ionized portion in general of these electrolytes that the abnormality is to be attributed.

As I have already indicated, this conclusion is not altogether novel, but in my opinion it has not been sufficiently emphasized. Even in discussions where it is formally admitted that the divergence from the dilution law may be due to the non-ionized portion, yet the argument is almost invariably conducted so as to throw the whole responsibility on the ions. The point which ought to be made clear is whether the constant k of the equation

$$\frac{dx}{dt} = kc_i^2,$$

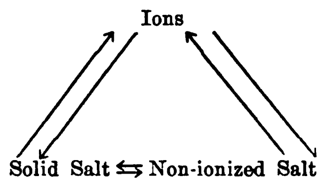
or the constant k' of the reverse equation

$$-\frac{dx}{dt} = k'c_u,$$

is really constant. If the former, then the ions are truly normal, and primary explanations of the abnormality of the strong electrolytes can scarcely be sought in high total ionic concentrations and the like, though a connection between the two no doubt exists, both being determined by the same cause.

In my illustration I have assumed that there holds good a dilution law of the kind given by Storch, of which van 't Hoff's dilution law is a particular case. Here the active mass is represented as a power of the concentration other than the first power. The argument I have used is altogether independent of this special assumption; the active mass of the abnormal substance may be any function of its concentration, and the same conclusion will be reached.

Nernst's principle of the constant ionic solubility product affords additional evidence that the ions act normally in solution. In deducing this principle it is generally assumed that it is the constant solubility of the non-ionized salt that determines the final equilibrium. This assumption, though convenient, is not necessary. The equilibrium is a closed one, thus:



The solid is not only in equilibrium with the non-ionized salt but also with the ions. Now, in the deduction of the change of solubility caused by the addition of a substance having one ion in common with the original electrolyte the mass-action law for ionization is assumed. This is of course justified when we deal with feeble electrolytes, but in the case of salts and strong acids which do not follow the mass-action law the experiments are found still to be in harmony with the theoretical deductions. This is not only so when the two substances in solution are both abnormal, but also when one is abnormal and the other normal, no matter which is used to produce the saturated solution. In fact, the principle of the constant ionic solubility product may be employed with equal success to calculate the effect on the solubility of one electrolyte of the addition of another electrolyte with a common ion, whether both electrolytes are normal, both abnormal, or whether one is normal and the other abnormal. At

first sight, this apparent obedience of abnormal electrolytes to the mass-action law seems strange, but a little consideration shows that if it is only the non-ionized portion of a salt that is truly abnormal, the theoretical result is to be expected. Suppose that the ions do behave normally in the ionization, then they must also act with normal active mass with reference to the solid, with which they may be regarded as in direct equilibrium according to the closed scheme referred to above. A change, then, in the concentration of any one of the ions, brought about by the addition of a foreign salt with that ion, will necessarily bring about the change in solubility of the salt calculated from the mass-action law, so far at least as experiment can tell us, for any variation from theory is caused by the change in the nature of the solvent due to the addition of the foreign substance. We ought, then, on the assumption that the ions behave normally, to expect that the principle of the constant solubility product would yield results of the same degree of accuracy in dilute solutions whether the electrolytes considered were normal or abnormal. This, as I have said, is actually the case.

To put the whole matter briefly, in the equilibrium between electrolytes agreement will be obtained between theory and experiment whether we use the mass-action law, or an empirical law such as van't Hoff's dilution formula, provided only that we attribute the abnormality to the non-ionized portion of the electrolyte. Thus we can deduce the ordinary formulæ for hydrolysis or for isohydric solutions as readily for abnormal as for normal electrolytes, and find the most satisfactory agreement with experiment in both cases.

By this one simple assumption, then, for which I have offered some direct justification, it is possible to find a basis for calculation with abnormal electrolytes. The problem of *why* certain electrolytes should be normal and others abnormal is, of course, in no way touched by this assumption. That is a matter for further investigation and research.

Another great desideratum of the theory of solutions is to find a general basis for the calculation of hydrates. The present position of the theory of hydrates in solution may perhaps most aptly be compared to the theory of electrolytic dissociation for solvents other than water. That hydrates exist in some aqueous solutions is undoubted, but no general rule or method exists for determining what the hydrates are and in what proportions they exist. Similarly the theory of electrolytic dissociation applied to other than aqueous solutions affords no general means of determining what the ions are and how great is the degree of ionization. It is only for aqueous solutions that Arrhenius was able to give a practically realizable definition of degree of ionization, and it is on this definition that the whole effective work on aqueous electrolytes is based; and until some general practically applicable principle of a similar character is attained for hydrates, the work done on that subject, however interesting and important it may be in itself, must necessarily be of an isolated character.

Arrhenius did not originate the doctrine of electrolytic dissociation or free ions: that was enunciated in 1857 by Clausius, and remained relatively barren. What he did was to introduce measurable quantities into the doctrine, and to show its simple quantitative applicability to aqueous solutions; immediately it became fertile. And as soon as a simple quantitative principle is developed for hydrates in solution, that doctrine will become fertile also.

It is surely now time that all the irrelevant and intemperate things that have

been said and written by supporters of the osmotic pressure and electrolytic dissociation theories on the one hand, and by those of the hydrate theory on the other, should be forgotten. Far from being irreconcilable, the theories are complementary, and workers may, each according to his proclivity, pursue a useful course in following either. One type of mind finds satisfaction in using a handy tool to obtain practical results; another delights only in probing the ultimate nature of the material with which he works. For the progress of science both types are necessary—the man who determines exact atomic weights as well as the man who speculates upon the nature of the atoms. That the want of knowledge as to what the exact nature and mechanism of osmotic pressure is, should prevent accurate experimental work being done on it, or interfere with its use in theoretical reasoning, is equally ridiculous with the proposition that because in the theory of osmotic pressure we have a good quantitative tool for the investigation of solutions, therefore we should abandon altogether the problem of its nature.

The fundamental ideas of a science are the gift to that science of the few great masters; the many journeymen investigators may be trusted to utilize them according to their abilities. Having once given his great principles to the world, van 't Hoff remained practically a spectator of their development; but by his single act he provided generations of chemists with useful and profitable fields for their labor.

J. Walker

THE COAL PRODUCTION OF PENNSYLVANIA

Pennsylvania's coal production in 1910 was 235,006,762 short tons, valued at $313,304,812. Of this 84,485,236 short tons was anthracite, valued at $160,275,302, and 150,521,526 short tons was bituminous coal, valued at $153,029,510. Compared with 1909, when the total production of the state amounted to 219,037,150 short tons, valued at $279,266,824, the production in 1910 shows an increase of 15,969,612 short tons, or 7 per cent., in quantity, and of $34,037,988, or 12.2 per cent. in value. Of the total increase 3,314,877 short tons was in the production of anthracite and 12,554,735 short tons in the production of bituminous coal. The value of the anthracite production showed an increase of $11,093,713, or 7.4 per cent., and that of bituminous coal increased $22,944,273, or 17.64 per cent. Although the quantity of bituminous coal produced exceeded that of anthracite by nearly 80 per cent., the value of the anthracite product was larger than that of the bituminous output by nearly $7,250,000. Bituminous coal represented 63.6 per cent. of the total output and anthracite represented 51 per cent. of the total value.

The anthracite mines of Pennsylvania gave employment to 169,497 men, who worked an average of 229 days. The bituminous mines employed 175,403 men for an average of 238 days. The average production for each man employed in the anthracite region was 498 short tons during the year. In the bituminous mines the men averaged 825 tons each. The daily average production for each employee in the anthracite region was 2.17 short tons and in the bituminous districts it was 3.61 tons. According to the Pennsylvania Department of Mines 601 men were killed and 1,050 were injured in the anthracite mines in 1910. The fatal accidents in the bituminous mines numbered 539 and the nonfatal accidents numbered 1,142.

In the combined production of anthracite and bituminous coal Pennsylvania outranks any of the coal-producing countries of the world except Great Britain and Germany, and in 1910 it came within 10,000,000 short tons, or less than 5 per cent., of equalling the output of Germany. Pennsylvania's production in 1910 was more than four times that of Austria-Hungary in 1909, and more than five times that of France in 1910, and nearly 20 per cent. of the total coal production of the

world. From 1829 to and including the first year of the present century Pennsylvania contributed over 50 per cent. of the total coal production of the United States and still produces between 45 and 50 per cent. of the total. The industry, particularly in the bituminous districts, has kept pace with the manufacturing industries and has increased in considerably larger ratio than the population of the state and of the United States as a whole.

Anthracite mining began in Pennsylvania in 1814, when 20 long tons were produced for local consumption. The year 1820 is, however, usually considered to mark the beginning of the anthracite industry, as in that year 365 long tons were shipped from the anthracite region. From 1814 to the close of 1910 the total production of anthracite had amounted to 1,946,717,383 long tons, or 2,180,323,469 short tons.

The first records of bituminous-coal production in Pennsylvania are for the year 1840, when 464,826 short tons were mined. The total output of bituminous coal from 1840 to the close of 1910 has amounted to 2,251,737,097 short tons, from which it appears that the total production of anthracite and of bituminous coal in Pennsylvania has been nearly equal. At the close of 1908 the total production of anthracite from the earliest times to the close of that year had exceeded the total bituminous production by approximately 51,000,000 tons. As, however, the production of bituminous coal in 1909 and 1910 exceeded that of anthracite by more than 122,000,000 short tons, the total production of bituminous coal now exceeds that of anthracite.

THE MEMORIAL TO ANTON DOHRN

At a meeting of the International Zoological Congress held at Graz in August, 1910, a plan was initiated to establish a memorial to the late Professor Dohrn, the founder and director of the Zoological Station at Naples. It may be doubted whether any other single institution has equaled this one in its contributions to the progress of biology in the past thirty years. To its development Dohrn devoted the whole energy of a singularly forceful and many-sided personality, laboring incessantly to keep the station fully abreast of modern progress, to enlarge its scope and to improve its equipment and methods, until it stood among the foremost of biological laboratories. It long since became a gathering place for investigators from many countries, and the influence that these men carried with them to their own institutions of learning made the Naples Zoological Station a potent force in the progress of biological science throughout the world.

Dohrn's far-reaching influence upon biology was due as much to his rare personal qualities as to his scientific work. He took a keen interest in the work of other investigators, even in fields far removed from his own, and was always ready with encouragement, particularly to younger men. Those who had the good fortune to come under his kindly and stimulating influence will not forget the debt they owe him. Beyond all this, the versatility of his human interests and his genius for friendship made him the center of an ever-widening circle that knew no limits of occupation or of nationality, and he was a force in the life of his time that is not to be measured by technical achievement alone but by a higher standard.

At the Zoological Congress it was proposed to establish a memorial of Dohrn's life and work, to include (1) a bronze portrait relief, to be erected in the laboratory at Naples, and (2) an endowment fund to aid in carrying on the steadily expanding work of the station. It is fortunate for the first of these aims that Dohrn had given sittings shortly before his death to the eminent sculptor Hildebrand, of Munich, who has executed a beautiful work of art that is well worthy of the present purpose. The need of additional funds for the station, as a result of the constant expansion of its work, was a subject of much concern to Dohrn in the latter part of his life. Those who knew him best feel sure that no form of memorial, could he have foreseen it, would have been

more welcome to him than the establishment of a permanent fund for this purpose.

The present movement was begun by the formation of a central committee, under the chairmanship of Professor von Graff, the president of the congress, with Professor Boveri as general secretary. This committee designated a number of persons to organize the work in various countries; and to this end national subcommittees have now been formed and are at work in most of the European countries. The American subcommittee includes about thirty biologists, and in addition a considerable number of others whose immediate interests do not lie in the field of scientific study. The hospitality and consideration which so many American students and investigators owe to Professor Dohrn, and the important influence exerted by the station on the progress of American science, justify the hope that this country will make generous response to an appeal for funds. The American subcommittee has formed an executive committee with the following membership:

Charles R. Crane, Chicago, Ill., president of the board of trustees of the Marine Biological Laboratory at Woods Hole.

Charles B. Davenport, director of the Carnegie Station for Experimental Evolution, Cold Spring Harbor, L. I., N. Y.

Frank R. Lillie, University of Chicago, director of the Marine Biological Laboratory, Woods Hole.

Jacques Loeb, Rockefeller Institute, New York, N. Y.

Hon. Seth Low, New York City.

Alfred G. Mayer, director of the Carnegie Marine Laboratory, Tortugas, Fla.

Henry F. Osborn, president of the American Museum of Natural History, New York City.

Stuart Paton, Princeton University.

George H. Parker, Harvard University.

William E. Ritter, director of the San Diego Marine Laboratory, La Jolla, Cal.

Isaac N. Seligman (treasurer), New York City.

Charles D. Walcott, secretary of the Smithsonian Institution, Washington, D. C.

Paul M. Warburg, New York City.

Edmund B. Wilson (chairman), Columbia University, New York, N. Y.

Mr. Seligman has kindly consented to serve as treasurer for the American subcommittee. Subscriptions of any amount, however small, will be welcomed. Checks should be drawn to the order of the Anton Dohrn Memorial and sent to Mr. Isaac N. Seligman, treasurer, care of J. and W. Seligman & Co., No. 1 William St., New York, N. Y.

Edmund B. Wilson,
Chairman of the American Subcommittee

Columbia University,
New York, N. Y.

SCIENTIFIC NOTES AND NEWS

Mr. Waldemar Lindgren, who has been connected with the U. S. Geological Survey since 1884 and since 1907 has been in charge of the investigations of metalliferous deposits and of metal statistics, has been elected chief geologist in succession to Dr. C. Willard Hayes.

It is reported that the Nobel prize for medicine will be awarded this year to Professor Allvar Gullstrand, of the Upsala University, for his work on the dioptrics of the eye.

Dr. Charles R. Van Hise, president of the University of Wisconsin and formerly professor of zoology, has been elected a fellow of the American Academy of Arts and Sciences, of Boston.

Dr. Simon Flexner has received from the German government an appointment as honorary member of the Institute for Experimental Therapy at Frankfort-on-the-Main.

The doctorate of science has been conferred by the University of Bristol on Mr. A. P. Chattock, sometime professor of physics in the university; Professor Julius Wertheimer, B.Sc., principal of the Merchant Venturers' College and dean of the faculty of engineering in the university, and Professor Sir William Ramsay, F.R.S., sometime principal of University College, Bristol.

Mr. Eli S. Haynes, who has been in charge of the Laws Observatory at the University of Missouri, has been appointed a university fellow in astronomy at the University of California.

Mr. A. B. Stout, of the University of Wisconsin, has been appointed director of the laboratories of the New York Botanical Garden to succeed Mr. Fred. J. Seaver, who has been transferred to a curatorship.

Dr. Eugene P. Humbert, associate biologist of the Maine Agricultural Experiment Station, has resigned to become agronomist in the Agricultural College and Experiment Station of New Mexico.

Sir William E. Smith, C.B., superintendent of construction accounts and contract work, has been appointed to succeed Sir Philip Watts, K.C.B., F.R.S., as director of naval construction for Great Britain.

Professor A. J. Cook, the veteran head of the department of biology at Pomona College, Claremont, California, has been appointed by Governor Johnson horticultural commissioner of California. He succeeds Mr. J. W. Jeffrey, who has held the office for seven years. Professor Cook was for many years prior to 1891 connected with the Michigan Agricultural College. He has written a number of books about horticultural subjects and is the author of a manual of apiculture. The position to which he has just been appointed is one of great importance, especially on account of the quarantine measures permissible under the California law and which look toward the prevention of the importation of new insect pests and plant diseases.

E. R. Hedrick, professor of mathematics; J. L. Meriam, professor of school supervision; M. F. Miller, professor of agronomy, and F. P. Spalding, professor of civil engineering, have returned to the University of Missouri after a year's leave of absence.

Professor A. E. Guenther, of the University of Nebraska, has been granted a leave of absence for the present academic year. He has received a special fellowship in the department of physiology of Columbia University, where he is engaged in research work.

Dr. Arthur Hollick, curator of the New York Botanical Garden, has been granted a leave of absence for the purpose of continuing his study of the paleobotanical material collected by him in Alaska in 1903, under the direction of the U. S. Geological Survey.

Sir Frederick W. Moore, director of the Royal Botanical Gardens, Dublin, has returned from a visit to the eastern United States and Canada.

Dr. Charles W. Eliot, president emeritus of Harvard University, whose departure for Europe was noted in the last issue of Science, goes, it is now announced, as a representative of the Carnegie Endowment for International Peace. Dr. Eliot will proceed, *via* the Suez Canal route, to India, and after spending some weeks in that country, will reach China in the month of February. If conditions in China permit, he will make an extended journey through the interior of the country, visiting the leading statesmen and men of affairs and conferring with them as to the objects of his visit. An important part of Dr. Eliot's work will lie in Japan, which he expects to reach in April, 1912. Dr. Eliot will return to the United States in July next.

The first course of Wagner Free Institute of Science lectures under the Richard B. Westbrook foundation will be delivered early in 1912 by Professor Morris Jastrow, Jr., on "Civilization in Ancient Babylonia and Assyria." The course will consist of five lectures, the exact dates and sub-topics of which will be announced later. The lectures will be free to the public.

At the installation of the honorary fraternity Phi Kappa Phi at the Iowa State College of Agriculture and Mechanic Arts, on October 23, President Edwin E. Sparks, of the State College of Pennsylvania, delivered an address on "Shifting Ideals of Student Life."

Dr. Nansen, who is to give an address before the Royal Geographical Society next month, has arranged to arrive in London in time to preside at the lecture which Sir Ernest Shackleton is to deliver on Friday evening, November 3, at the University of London.

A bronze monument to the memory of Amedeo Avogadro was unveiled at Turin on September 24, erected, as the result of an international subscription, under the auspices

of the Royal Academy of Sciences of Turin. We learn from *Nature* that the king of Italy presided at the inauguration ceremony, which was attended by nearly all the more eminent Italian chemists and physicists, as well as by a number of representatives of foreign academies, including M. Haller, of the Paris Academy of Sciences; M. Moureu, of the Chemical Society of France; Professor Nernst, of the Chemical Society of Berlin, and M. Guye, of the Geneva Society. The date selected was the centenary of the publication of Avogadro's celebrated memoir.

GEORGE WILLIAM JONES, professor of mathematics at Cornell University from 1877 to 1907, when he became professor emeritus, died on October 29, aged seventy-four years.

M. LOUIS GRANDEAU, formerly general inspector of the French Agricultural Station, has died at the age of seventy-seven years.

PROFESSOR PAUL B. RICHTER, of the Royal Gymnasium at Quedlinburg, Saxony, who devoted much of his time to the study of the Cretaceous fossil plants of that kingdom, died on October 9, at the age of 57.

DR. JULIUS VON MICHEL, professor of ophthalmology and director of the eye clinic of the University of Berlin, has died at the age of sixty-seven.

UNIVERSITY AND EDUCATIONAL NEWS

ANNOUNCEMENT is made that the action brought by the children of the late Mrs. George Crocker to recover the residence at No. 1 East Sixty-fourth street and its contents, which form a part of the legacy given by the late George Crocker to Columbia University for the study of cancer, has been discontinued with the consent of the plaintiffs upon the payment to them by Columbia University of $60,000, the equivalent of interest at three per cent. for two years on the amount the plaintiffs claimed.

SUBSCRIPTIONS for $150,000 to meet the conditional pledge of $50,000 from the General Education Board have been received by Middlebury College. One half of the fund will be reserved for general endowment, while $50,000 will be expended for a gymnasium.

MOUNT HOLYOKE COLLEGE has received a bequest of $5,000 from S. Newton Cutter, of Somerville, Mass., the income of which will be used for the purchase of books for the library.

MR. E. B. BURLINGAME, of Providence, has presented to Brown University his botanical herbarium of some 3,000 specimens.

BEGINNING with the session of 1911–12, the University of Missouri will require two years of college work for admission to all professional schools, except the College of Agriculture.

A NEW system of granting honors for university work has been started at the University of Wisconsin. Hereafter, special recognition will be granted at the end of the second year and at graduation. Honors at the end of the sophomore year will be granted for unusual excellence of work carried on in at least two different departments. Graduation honors will be of two kinds. First, honors will be awarded for an exceptionally original and scholarly thesis, without any consideration of the writer's previous record. Second, honors will be granted for a general high average of the required work done throughout the entire course, supplemented by independent work done in at least two subjects.

AT the annual meeting of the Association of American Universities, held at the Reynolds Club of the University of Chicago on October 26 and 27, twenty-one of the leading universities of the country were represented. The principal question before the association was the unification of the requirements for graduate work in major studies. Among those who took a prominent part in the discussion were Presidents Strong, of Kansas; Lowell, of Harvard; Wheeler, of California; Vincent, of Minnesota; Hill, of Missouri; Alderman, of Virginia, and Judson, of Chicago.

YALE, Columbia, Johns Hopkins, Virginia, Illinois and Minnesota have joined in an arrangement for an exchange of professors with Japan. Under the terms of this agreement Japan will be represented for four weeks at each of the above named institutions, the coming year by Dr. Ignazo Nitobe, of Tokio,

Japan. Each of the seven universities contributes five hundred dollars every other year to send a representative from the United States to Japanese universities.

Preparations are under way for the centennial commencement of Hamilton College on June 17, 1912. Senator Elihu Root, chairman of the board of trustees, has announced that President Taft and Vice-President Sherman will deliver addresses.

Governor Stubbs, of Kansas, Chancellor Frank Strong and regents William Allen White, Rodney A. Elward and Scott Hopkins, of the University of Kansas, have spent three days at the University of Wisconsin studying its methods with special reference to the extension of its work in education throughout the state.

Dr. Thomas E. Hodges was installed as president of the University of West Virginia on November 1.

By the appointment of Professor H. C. Peffer as professor of chemical engineering at Purdue University, this department has been raised to the status of a school coordinate with those of civil, electrical and mechanical engineering, and made independent of the department of chemistry, which, however, will continue to give instruction in general, organic and analytic chemistry. Professor Peffer will, during the current year, give instruction to seniors in industrial organic chemistry and metallurgy, and direct the preparation of graduation theses. Professor Peffer is a graduate (B.S. 1895 and M.S. 1907) of Pennsylvania State College and has been connected as chemist or superintendent with the Carnegie Steel Co., the Pennsylvania Salt Co. and the Pittsburgh Reduction Co., now the Aluminum Company of America.

At the University of Missouri the following appointments have recently been made: W. J. Calvert, M.D. (Johns Hopkins), professor of preventive medicine; J. A. Ferguson, M.F. (Yale), professor of forestry; R. H. Baker, Ph.D. (Pittsburgh), assistant professor of astronomy and director of the Laws Observatory; H. L. Kempster, B.S. (Michigan Agricultural College), assistant professor of poultry husbandry; Lawrence G. Lowrey, A.M. (Missouri), acting assistant professor of anatomy; A. J. Meyer (formerly of Wisconsin), assistant professor and superintendent of the two-year course in agriculture; Matthew Steel, Ph.D (Columbia), assistant professor of physiological chemistry; G. S. Dodds, Ph.D. (Pennsylvania), instructor in zoology; O. F. Field (formerly of Nebraska), instructor in physical education; R. L. Gainey, A.M. (Washington University), instructor in botany; Paul Phillips, B.S. (Missouri), instructor in manual arts; Ralph E. Root, Ph.D. (Chicago), instructor in mathematics; W. A. Tarr, S.B. (Arizona), instructor in geology and mineralogy. The following promotions have been made: E. A. Trowbridge, from assistant professor to professor of animal husbandry; C. B. Hutchinson, from instructor to assistant professor of agronomy; Horace F. Major, from instructor to assistant professor of landscape gardening; O. W. H. Mitchell, from instructor to assistant professor of pathology; H. C. Rentschler, from instructor to assistant professor of physics; J. C. Hackleman, from assistant to instructor in agronomy; L. G. Rinkle, from assistant to instructor in dairy husbandry; Warren Roberts, from assistant to instructor in civil engineering.

DISCUSSION AND CORRESPONDENCE

CHROMOSOMES AND ASSOCIATIVE INHERITANCE

The difficulties that Emerson finds in the chiasma type hypothesis are not, I think, as serious as he states (Science, October 20, 1911); and since the hypothesis appeared to meet the situation so exactly I ventured to suggest that it might be worth consideration. My brief reference to this postulated mechanism (Science, September 21, 1911) seems not to have been entirely understood by Emerson, for which the brevity of the statement, or failure to express myself clearly may be responsible, but by reference to Janssens's paper ("La Cellule," 1909) I had hoped a brief statement would suffice. In fact, the only difficulty of any weight raised by Emerson is not a dif-

ficulty at all when the chiasma type of cross union between the homologous chromosomes is grasped; the difficulty arising rather from my attempt to express in a sentence or two the essence of the mechanism described by Janssens. I said that the well-known twisting of the chromosomes giving a spiral line of separation was followed by a splitting in a single place. Emerson properly objects that if this were strictly carried out some of the genes, those at the nodal points, might be divided quantitatively. In reality according to Janssens the chromosomes break at the nodal point and unite so that the two resulting chromosomes consist of pieces (two or more) of each of the original members of the pair. If, then, the genes do not themselves split when the chiasma is formed there is no opportunity offered for a quantitative division. This is the mechanism that Janssens describes as I understand it.

A second point raised by Emerson is likewise not a serious difficulty, although we need further facts in different animals and plants concerning the nature of the chiasma type before we can speak positively about the matter. Emerson asks how if the mechanism explains the facts of coupling in those cases where some interchange must be admitted (in a case like that of *Drosophila*, for example), can we account for the purity of certain races where certain characters remain coupled and never interchange? My answer is, first, that the hypothesis was offered primarily to account for those cases where the coupling is not absolute and crossing must be admitted; and second, that whether interchange does or does not occur will depend primarily on the nature of the chiasma type; whether, for example, crossing takes place at certain levels (stations) more likely than at others or whether it is entirely a chance crossing. Until cytologists have settled this matter we may leave the question open; but the very latitude that this mechanism offers seems to me to fit the situation far better than one that admits of no such freedom; for the facts themselves are diverse. That complete coupling of several characters may exist, such as yellow, black and chocolate in mice is clear; and the result in such cases may be due to the region of the chromosome (that contains the factors for these colors) holding together as a unit when the chiasma forms; while in other cases the union between a similar series of factors may not be so close, so that crossing is more likely to take place.

As to "what has become of the 'individuality' of the chromosomes" if interchange between homologous pairs be admitted, is a matter of very small consequence; since Boveri, who is the chief exponent of the hypothesis of individuality, has long since admitted such an interchange in his definition; and since the facts of Mendelian inheritance call for such an interchange, if the chromosomes be admitted as the most likely vehicles of hereditary factors. All that my hypothesis pretends to account for is that groups of factors that enter together tend to remain together. The chiasma type appears to explain how such union may remain; perhaps some other mechanism may be found that will do as well. *The important point is that the coupling (association) of sex-limited characters that I have found in Drosophila shows that the factors must be referred to the same chromosome, and if so there seems to be no escape from the conclusion that interchange as well as association must be admitted on the chromosome hypothesis.*

Emerson has himself suggested a view to explain the remarkable cases of coupling that he has found in corn.[1] His hypothesis requires that in those cases where no interchange takes place the coupled factors lie in homologous chromosomes, while in those cases where interchange takes place the same or similar factors are contained in non-homologous chromosomes. This may seem probable or improbable, as one prefers, but in the case of *Drosophila,* where the factors in question are sex-limited and coupled with the sex chromosome, we see that his hypothesis can not hold, and that the facts can be explained without need of such an hypothesis.

[1] Annual Report Nebraska Agricultural Experiment Station, 1911.

If I might venture to point out what seems to me to be the weak point in my own view I should regard the evidence that the crossing observed in the chiasma type really takes place is by no means as yet established (see Gregoire, "La Cellule," 1910); for, while the twisting can not be doubted it is still an open question as to whether the chromosomes may untwist before the "split in one plane" appears.

T. H. Morgan

Columbia University

THE COTTON WORM

To the Editor of Science: In connection with the correspondence of Dr. H. T. Fernald in the October 13 issue of Science on the cotton worm in Massachusetts, it may be interesting to note that there has been a very heavy migration of this insect (*Alabama argillacea* Hubn.) in the city of Pittsburgh this year. The moths began to arrive about the tenth of September and reached the maximum numbers on September 23, on which date hundreds were to be found on electric light poles and buildings in the heart of the city and passing street cars stirred up swarms from sunny places. The insects are still present (October 17) but not in very large numbers.

John L. Randall

THE AIR BLADDER IN CLUPEA HARANGUS

In Science (October 13, 1911) I described the air-bladder of *Ophiocephalus* and called attention to the desirability of an investigation of the condition of the posterior duct to the air-bladder in *Clupea harangus*. In this connection Dr. Gill has kindly called my attention to a lecture by Professor Huxley, published in *Nature* (April 28, 1881) in which he (Huxley) shows conclusively that *Clupea* has the posterior duct actually open to the exterior.

E. C. S.

QUOTATIONS

BENZOATE OF SODA AGAIN

The American public believes that a question is not settled until it is settled right. This probably accounts for the fact that the sodium benzoate question will not down. And yet, although volumes have been written on this much controverted subject, the problem itself is really a simple one. There are three basic facts on which all are agreed: First, no one denies that sodium benzoate in foods may prove harmful in certain quantities, under certain conditions or when given to certain classes of individuals. Second, no one denies that foodstuffs of a high quality can be put up without the use of sodium benzoate; in fact the best food manufacturers do not use this chemical. Third, no one denies that when this chemical is used, scrupulous cleanliness and extreme care in handling are no longer necessary. These are three incontrovertible facts, admitted grudgingly or frankly, as the case may be, by both pro- and anti-benzoate forces. Under the circumstances, then, it is not irrational to conclude that sodium benzoate should not be used as a food preservative.

And now comes from Berlin the "Expert Opinion of the Royal Scientific Deputation for Medical Affairs Regarding the Use of Benzoic Acid and its Salts for the Preservation of Food." These experts were requested by the Minister of Education and Medical Affairs in Germany to give their opinion on this subject. In their report, they first describe the chemical and physiologic action of these drugs and then briefly summarize the findings of various scientists on the question at issue. Of the decision of the United States referee board, these German scientists say:

> The series of experiments in this connection made by the American scientists are of too short duration and the results coupled with certain limitations, so that they can not be regarded as demonstrating the unconditional non-injurious nature.

After considering all of the evidence on the subject the Scientific Deputation for Medical Affairs reaches the following conclusions:

> In regard to the admissibility of the use of benzoic acid and its salts for the preservation of food it is mentioned that in France on the basis of a decision of the Commité consultatif d'hygiène publique of October 1, 1888, the Minister of Justice

in his circular dated October 16, 1888, prohibited the use of benzoic acid in drinks and food.

In Austria the Supreme Sanitary Council in an expert opinion dated December 16, 1899, decided in favor of a prohibition of preserving substance containing benzoic acid or its salts, and has adhered to this standpoint in a recent expert opinion and given a detailed justification of the same. In the same sense the Saxon Landes-Medizinal-Kollegium expresses itself.

The Scientific Deputation for Medical Affairs is likewise of the opinion that the use of benzoic acid and benzoic acid salts for the preservation of food should not be permitted. Even if small doses of the same may be considered harmless for the human organism there is still a danger that, with the addition of these substances to the various food and drinks on the whole quantities would be daily consumed, which would be injurious to the organism. This fear is particularly justified in the case of children, the aged, and weak or sick persons, whereby it is to be observed that even in the case of normal food not preserved with benzoic acid substances are introduced from which benzoic acid comes into existence in the body.

A further objection against the use of chemical preservatives at all consists in the fact that in its use the food intended for consumption may not be handled with the necessary care and cleanliness to prevent its decay or injury by fungi and that, being neglected by the manufacturers and sellers, under certain circumstances the quality of the goods would suffer. . . .

Similar objections exist regarding albuminous food liable to decay. The experiments of the imperial health office have demonstrated among other things that a slight smell of decay in chopped meat may be concealed, but not entirely removed, by merely stirring or turning over the meat; but on mixing with 0.25 per cent. benzoic acid or sodium benzoate the smell disappears for a time. By this process, therefore, food which has already commenced to decay can be given the appearance of freshness and the purchaser deceived as to its quality.

These findings agree exactly not only with the opinion officially expressed by the American Medical Association in its resolutions on this subject, but also with the opinion held by other scientific bodies and by the intelligent public generally. With the reorganization of the Department of Agriculture, which is as inevitable as it is necessary, it is to be hoped that the United States government will soon cease to hold its present inconsistent position on the subject of the use of sodium benzoate in foods. This chemical has no place in the dietary of any people and certainly its legalized use is a disgrace to an enlightened nation.—*Journal of the American Medical Association.*

SCIENTIFIC BOOKS

Memorial Volume Commemorative of the Life and Work of Charles Benjamin Dudley, Ph.D., Late President of the International Association for Testing Materials and of the American Society for Testing Materials. Published by the American Society for Testing Materials, Philadelphia, Pa. 1911.

The book is, in fact, the proceedings of a memorial session held by the American Society for Testing Materials on June 29, 1910. The proceedings began with the presentation of a sonnet in memory of Charles Benjamin Dudley by Harvey W. Wiley and closed with a personal tribute by Robert W. Hunt. Other contributions to the proceedings consisted of discussions of several phases of Dr. Dudley's character, his life, and his work, by the different officers and members of the association, respectively, as follows: Introduction, by Vice-president Robert W. Lesley; Dr. Dudley as a Railroad Man, by Theodore N. Ely; Dr. Dudley as a Chemist, by Edgar F. Smith; Dr. Dudley as a Metallurgist, by Henry M. Howe; Dr. Dudley as a Mentor, by B. W. Dunn; Dr. Dudley as a Citizen, by W. H. Schwartz. These discussions were followed by minutes and announcements on the death of Dr. Dudley and copies of various papers and addresses by him.

The discussions of the phases of his character and life were all highly eulogistic, as might be expected, but everything said was fully justified. His life and character were worthy to be studied and copied by all, and particularly to be studied and used as an example and inspiration for young men. Mr. Lesley well summed up his character when he said, "he was a diplomat of the heart, a nobleman of nature's handiwork . . ." and further

he said most justly, "he was a kind and generous friend to the young men and particularly solicitous for their advancement."

These were the qualities which made Dr. Dudley so successful as president of the American Chemical Society. In that high office his kindly diplomacy and great tact enabled him to harmonize many conflicting interests, and to so largely help to advance the interests of the society and bring it to that excellent condition of harmony and efficiency which now prevails.

This book will be a valuable addition to all libraries and particularly to those of the younger generation. It should be read and pondered by all men.

William McMurtrie

Taschenbuch für Mathematiker und Physiker. By Felix Auerbach and Rudolf Rotha. Leipzig, B. G. Teubner. 2 Jahrgang, 1911.

The second volume of the "Taschenbuch" consisting of 580 pages, may not correspond to the American idea of a "Taschenbuch," but it is an unusually convenient "Handbuch" for mathematicians and physicists. A part of the table of contents is of value only or chiefly to residents of Germany—the calender for Berlin, the table of magnetic elements for central Europe, the "Verzeichnis der Hochschullehrer"—but with these exceptions the entire book is of general interest. The articles dealing with astronomical facts concerning planets and comets, the tables of astronomical and geodetic constants, the four-place logarithm tables of numbers and trigonometric functions, the tables of squares and Bessel functions, the numerous tables of all the important physical constants, call for no review. One notes, however, how admirable is the synopsis of the fundamental definition and operations of mathematics. A candidate for a doctor's degree in physics would do well to master the mathematical portion of this volume. Not only is here given the theoretical groundwork of the subject, there are also given labor-saving applications; *e. g.*, the complete Fourier's series are worked out for a number of common forms of the function. There is also an application to life-insurance mathematics.

The synopsis of the fundamental principles of physics, while lacking the continuity of the mathematical synopsis, is none the less complete. There is here condensed what one ordinarily finds spread over several volumes of general physics.

The article which will be of the greatest interest to readers of the "Taschenbuch" is that on the principle of relativity by Willy Wien. It is an historical and a critical summary, complete at least in its physical aspect. The contributions to this theory made by Minkowski are briefly set forth not only in this article but also in the review of Minkowski's work with which the book opens. That one who has contributed so much to this far-reaching theory should be cut off in the very prime of his power is to be greatly deplored. Physicists and mathematicians will be pleased to have the portrait of Minkowski which accompanies the article.

G. F. Hull

SPECIAL ARTICLES

CONCERNING A NEW ARRANGEMENT OF THE ELEMENTS ON A HELIX, AND THE RELATIONSHIPS WHICH MAY BE USEFULLY EXPRESSED THEREON

In this abstract of a paper which, under the title "Helix Chemica," has been published in *The American Chemical Journal*, Vol. XLV., p. 160, 1911, the writer wishes to explain briefly the grounds of the proposed arrangement and to illustrate by a few examples the many uses to which the helix may be put to bring out and compare the complex relationships of the elements.

In Fig. 1 the helix is presented from the side, in Fig. 2 from the end, where of course the front curve of each series hides those behind it. In Figs. 3–6 the curves are drawn as if they were on the end of a barrel, enabling one to see the groups and series at the same time. A great number of harmonic relations are presented on these figures, only a few of which can be discussed in this abstract. The system uses the series of Mendeléeff, but makes one half of each group the antithesis,

instead of the associate, of the other, thus separating dissimilar elements like copper and potassium.

The elements are placed in the order of their atomic weights, and with interspaces equal to the average difference of the atomic weights of adjacent elements. These differences are found to increase for the different groups of rings in the simplest arithmetical ratio 0 1 2 3 4, where, since the atomic weights are rarely whole numbers, the ratio numbers will not be exact digits, and the first term will be some very small number instead of exactly zero. The regularly recurring resemblances of the elements break them up into groups determining the number of circles of a given size and the number of interspaces and of elements upon each kind of circle; and all these relations are according to the same simplest geometrical ratio, 2 4 8 16 32. The length of each circle is obtained by combining these ratios.

Starting with the best determined circles, the lithium ring covers a range of atomic weights equal to sixteen ($H - Ne = 16$) and contains eight elements (an octant), and so the average interspace is put as two. The sodium series is wholly symmetrical with the Li ring, and so is put on a second equal coil of a spiral beside it. The third ring agrees exactly with the other two from potassium to titanium, potassium having valence and sp. gr. about like sodium and so on to titanium, which has valence and sp. gr. about 4, like silicon. Here the resemblance ceases, and vanadium, instead of agreeing with phosphorus, continues downward with valence and sp. gr. 5, and so on to the iron triad group with valence and sp. gr. equal to 8; and then the curve turns; valence and sp. gr. grow less (copper $=$ 7, zinc $= 6$, etc.), until the last half of this band from Ge to Br is exactly homologous with the rearward half (in Fig. 1) of the preceding circles. Thus is established a second larger type of circle containing sixteen elements (a double octant), and making an advance in atomic weight of about 48, so that the interweight becomes about 3 and the interspace in this circle is made 3. This changes the spiral into a helix. Four such circles can be constructed. If there are two octant circles with an interspace of 2, and four double octants with interspace 3, there should be 8 quadruple octants with interspace 4, but the curve advances only one quadrant of the first circle of this type, and does this with an interspace of 4, but becomes so complex that it falls asunder spontaneously, giving up atoms of helium whose combining weight is 4, indicating that the additions in this last curve have been by fours.

In the other direction symmetry demands a diminishing of the helix to a single half octant with interspace 1, and hydrogen stands at the beginning and helium (4) at the end of this ring. One must search among the nebulæ for elements light enough to fill the two gaps, and we find among the simpler spectra in the simplest nebulæ the lines 4,340 t.m. and 4,862 t.m. belonging to hydrogen, the next higher line, 4,959 t.m., belonging to nebulium, which has probably greater density than hydrogen because it is found more concentrated in the center of the nebulæ, for which reasons we may assume nebulium to be a dyad and to take the second place in our circle. The next higher line, 5,007 t.m., I have tentatively assigned to the next element in this half-octant, which, from its position, must be a halogen, and which I have called proto-fluorine. The next higher number, 5,876 t.m., belongs to helium—which completes the circle.

The helix must close with the half of a quarter-octant—a single element which must have valence $= 0$, a density much less than hydrogen, and atomic weight much less than unity. Where would one search for such an element better than in the corona? Indeed, coronium is found to be probably lighter than hydrogen, since its lines are found further from the sun than those of hydrogen. It occupies also the position of the second element extrapolated by Mendeléeff for which he obtained the atomic weight 0.4, and suggested its identity with coronium. I have, by a similar method, obtained the value 0.3, and the symmetry of the helix would suggest that it should be still smaller.

There remains only the origin of the curve where I have placed the letter E for the ether, electron, protyle or Urstoff, which must have a valence and density equal to zero,[1] and we may also almost say with an atomic weight of zero, since E is the x of Mendeléeff for which he calculated a hypothetical atomic weight equal to one-millionth that of the hydrogen atom. The numerical relations of the helix are summarized in the following table. The positions and the number of the elements on the different circles may be obtained by drawing a regularly increasing number of diameters to each succeeding type or circle. One vertical diameter is drawn in the quarter-octant, giving place at its ends for two elements. Two diameters are drawn at right angles in the half-octant for four elements. The angles are bisected by two other diameters, giving place for eight elements in the octants; and then again bisected, giving sixteen for the double, and a final bisection gives thirty-two for the quadruple octants.

TABLE OF THE SYMMETRIES OF THE HELIX

	Quarter Octave	Half Octave	Octaves	Double Octaves	Quadruple Octaves	
1. Length of interspace (= interweights) in each type of circle. (Approximate) Unit-curve = Cn — H.	0	1	2	3	4	Simplest arithmetical ratio.
2. Number of interspaces in each type of circle.	2	4	8	16	32	Simplest geometrical ratio.
3. Number of elements in each type of circle.	2	4	8	16	32	
4. Number of circles of each type.	½	1	2	4	8	
5. Number of elements in each circle, obtained from 4 and 2.	1	4	8	16	32	
6. Length of each type of circle, obtained by multiplying preceding ratios in 1 and 2.	0	4	16	48	128	Combination of above.

[1] G. T. Stoney, "The Non-existence of Density in the Elemental Ether," *Phil. Mag.* (5), Vol. 29, p. 467.

The helix is placed horizontally, so that the nullivalent elements shall form its axis—they being the lightest elements—from which each group is continued downward with symmetrical increase in valence and density on either side to a maximum in the triads at the bottom. The alkalis on the one side are the antitheses of the halogens on the other, and this maximum of dissimilarity decreases downward symmetrically on either side. In the double octants it reaches a valence of 8 and a corresponding specific gravity. In the octants the circle closes with a valence of 4. It is interesting that carbon, the element of life, and silicon, the element of the rocks, form the center of the figure and are both trimorphic like the triads at the bottom of the double octants. If the helix be cut along its axis and the curves opened out on a flat surface the table of the elements given below results. This shows that the newcomers intercalated between the homologues of the preceding group are three for the octave, nine for the double-octave and seventeen for the quadruple octave if there be a triad at the bottom of the large curve. Symmetry would demand a group of twelve at that place.

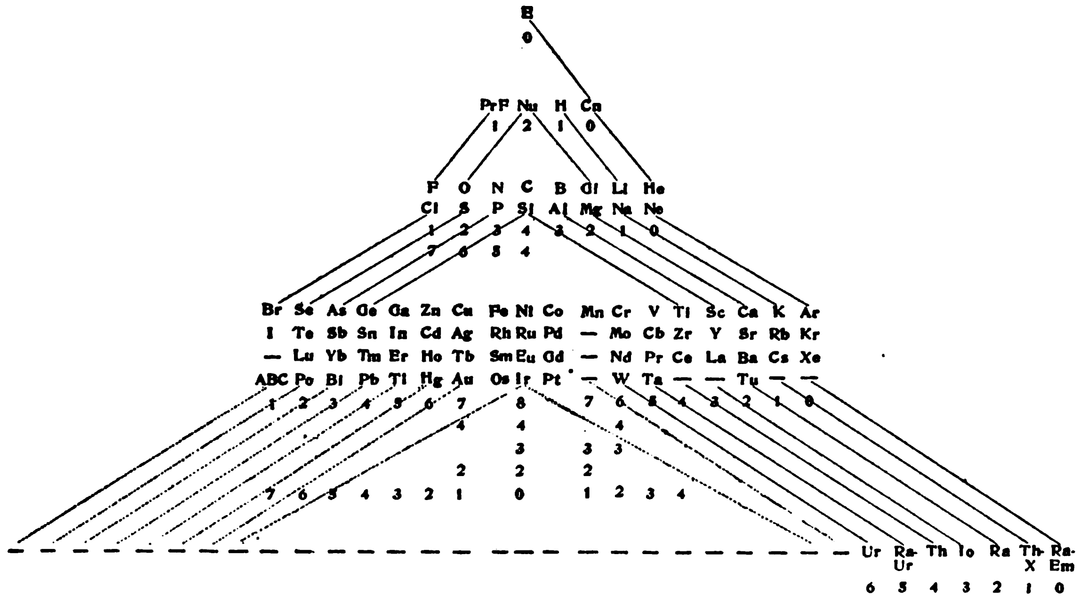
If the helix be cut along the lower line of densest elements and flattened out we have the following table, where, as the lowest elements have an equal right to be placed at either side, they are placed on both sides. This suggests the possibility that the second element beyond uranium would be the first member of a triad.

Doubtless a better suggestion would come from the preceding table, that there would be a triad or larger group at the bottom of the larger circle.

I. Longitudinal Relations. Fig. 1.

At the bottom of Fig. 1 is placed the atomic volume graph of Meyer: (1/sp. gr.) the specific volume graph of A. J. Hopkins,[2]

[2] *Jour. Am. Chem. Soc.*, July, 1911.



Periodic Table of Atomic Weights with Valence.

which puts specific volume in the place of atomic volume (at. w./sp. gr.), thus emphasizing the more important part of the atomic volume graph: the compressibility graph of T. W. Richards, changed to apply only to solids; and the graph of the fusion of the halogen compounds of Thomas Carnelley. These graphs are changed in size only to match the helix; and the exact agreement of the four large curves with the double octaves, the two small ones with the octaves, and the exact space left for the half octave is a strong confirmation of the naturalness of the helix. Further I have been able, by a very reasonable extrapolation, to prolong backward the atomic volume graph to match exactly the half and quarter octaves, and to show that its natural culminations are in the inert gases and not in the alkalis.

The law of longitudinal condensation is especially interesting. It is only in the middle or K circle (the one containing potassium and iron) that density and valence agree from 1 in K to 8 in Fe, so that density divided by valence (D/V) equals unity. In earlier circles D/V is less than 1, so that less matter is condensed into the atom that satisfies a given amount of H, and in later circles D/V is greater than unity and more matter is condensed into the corresponding atom. Thus the densities of the iron, rubidium, samarium and platinum triads are as $8:12:16:22+$ or $D/V = 1:1\frac{1}{2}:2:3$, and, if we omit gases and poorly determined elements,

										E										
								Nu	PrF	Cn	H	Nu								
						C	N	O	F	He	Li	Gl	B	C						
						Si	P	S	Cl	Ne	Na	Mg	Al	Si						
Fe	Ni	Co	Cu	Zn	Ga	Ge	As	Se	Br	Ar	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Ni	Co
Rh	Ru	Pd	Ag	Cd	In	Sn	Sb	Te	I	Cr	Rb	Sr	Y	Zr	Cb	Mo	—	Rh	Ru	Pd
Sm	En	Gd	Tb	Ha	Er	Tm	Yb	Ln	—	Xe	Cs	Ba	La	Ce	Pr	Na	—	Sm	Eu	Gd
Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	ABC	—	—	Tu	—	—	Ta	W	—	Os	Ir	Pt
-- —	—	—	—	—	—	—	—	—	—	RaEm	Thx	Ru	Io	Th	Ra Ur	Ur	—	—	—	— —

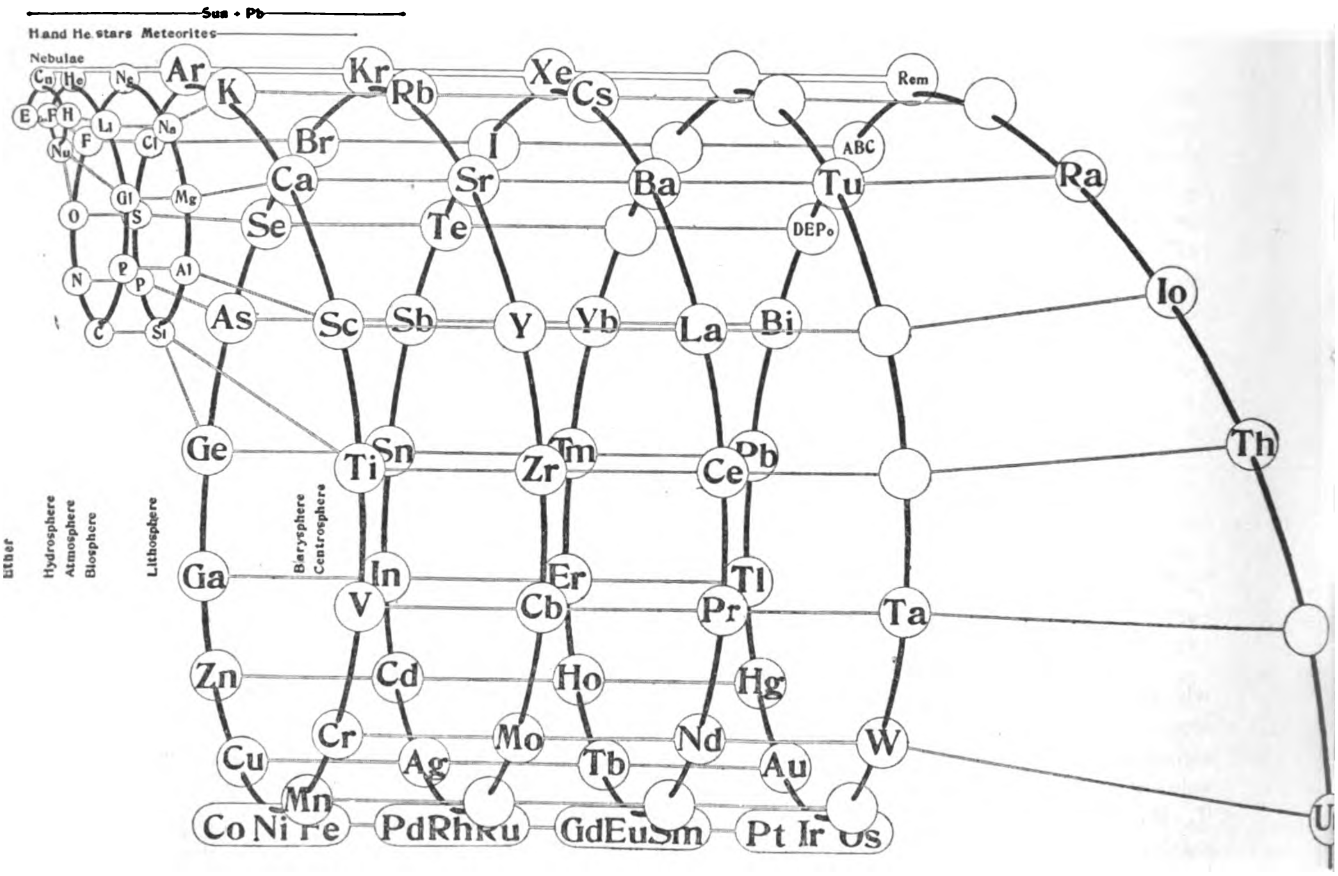


FIG. 1. A side view of the helix drawn to scale. The four graphs below have been changed, the alkalis and match closely the four double octaves, the two octaves and the half octave. The

the same ratio is true of the circles of which these triads are a part. So, omitting gases and the abnormal glucinum, we have for the carbon octave .52 and for the silicon octave .80. Thus we get, without forcing, the following average values for D/V for each of the seven circles

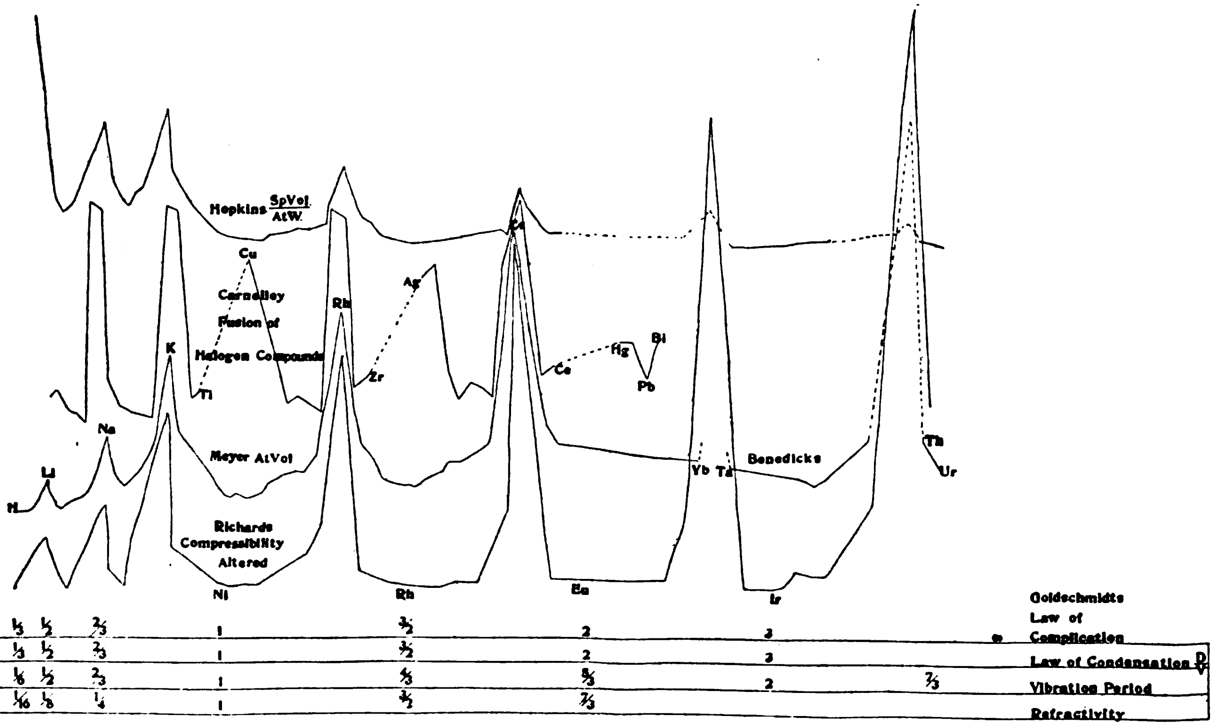
E	Nu	C	Si	Fe	Ru	Se	Pt
(0)	(1/3)	1/2	2/3	1	3/2	2	3.

This agrees with Victor Goldschmidt's law of complication[8] which shows that the law of increasing longitudinal condensation in the elements deduced above is the same as the law of the octave in music, and the fundamental law of crystallography, and the first two values given above are extrapolated in accordance with Goldschmidt's law.

Instead of omitting any elements as suggested above, a different and perhaps more useful line of thought may be followed. It may be assumed that the true relations would appear only when the specific gravities were taken under common conditions, say at —273°, since the elements expand unequally and sometimes diversely with change of temperature, so that we can obtain only approximate results from specific gravities taken at ordinary temperatures. We find the law most perfectly realized at the bottom of each circle at the point of greatest condensation.

Thus C as graphite is .5, Si as quartz is

[8] V. Goldschmidt, "Ueber Harmonie und Complication," Berlin, 1901.



in size only, to match the diagram. It will be seen that the apices of the same point exactly to table showing the longitudinal octave relations is placed below.

.66, iron is 1, rhodium is 1.5, all exactly following the law. The next circle is not determined and osmium is 2.8 + instead of 3.

Moreover, all the elements in the lower part of each curve keep close to this average, but as we pass up the left side of the curves into the region of lessened density we come upon a sudden sharp divergence from the law in the sulphur and halogen series, caused by the polymerization or allotropic states of these elements. If we divide the numbers of the sulphur and the first half of the halogen series by two and bromium and iodine by three we obtain numbers closely coinciding with the law in every case thus:

	Fl	Cl	Br	I	S	Se	Te
Obtained by division	.55	.65	1	1.7	5	1.1	1.5
Required by the law	.5	.67	1	1.5	67	1	1.5

We may further strengthen the argument for this polymerization by the following tabulation of the monovalent specific gravities or $\frac{\text{specific gravity}}{\text{valence}}$ of the elements in the carbon octant:

Li	Gt	B	C	N	O	Fl
			.3	.3		
			coal			
.58			.5		.5	
			graphite			
	.9	.9	.9			1.1
			diamond			

As carbon crystallizes as graphite at normal pressures we may take that as the normal form and .5 as the normal monovalent specific gravity. There is a partially known graphitic form for boron and we may divide all the numbers in the lower row by two to get approximately the specific gravity of these elements in a form analogous to graphite. With these two changes we get averages of all the elements in each circle as follows:

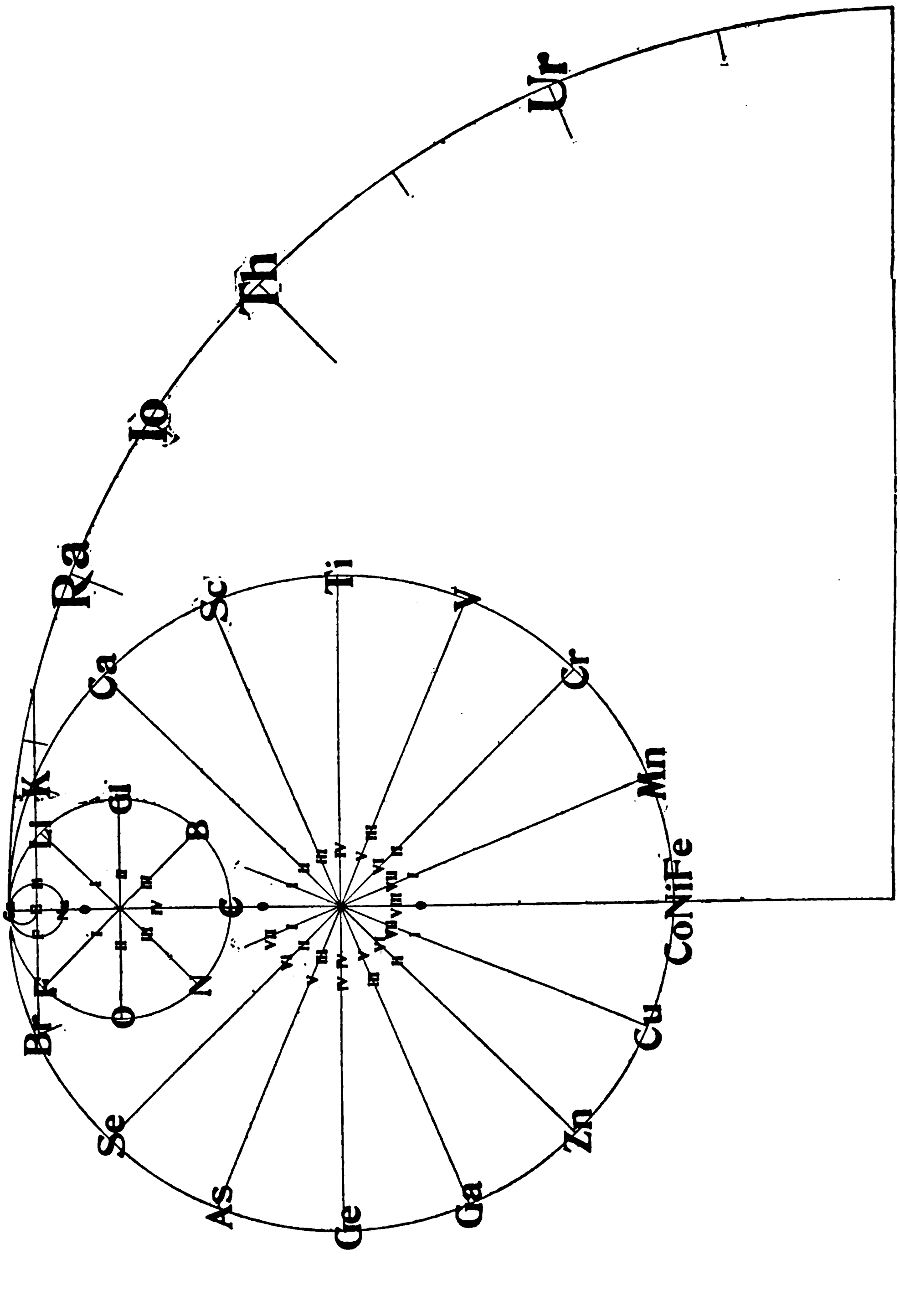


FIG. 2. An end view of the helix in true scale (except the curve E–Cn) showing only the first of the octaves and double octaves and symbolizing the increasing mass of the atoms. (The first F should be Proto F.)

	C circle	Si circle	Fe circle	Ru circle	Sm circle	Pl circle
Calculated	.48	.73	1.1	1.5	1.94	2.84
Required	.5	.67	1	1.5	2	3

The greatest irregularity in the whole list of the elements is in Na = .9, Mg = .88, Al = .85 instead of .67. The fact of this polymerization is forced on one by the inspection of a useful table of Woodiwis (*Chem. News*, Vol. 97, p. 122, 1908) who takes the combining weights as abscissas and the monovalent specific gravities (S.G./V.), to use his convenient term, as ordinates. This table shows that while the other elements are ar-

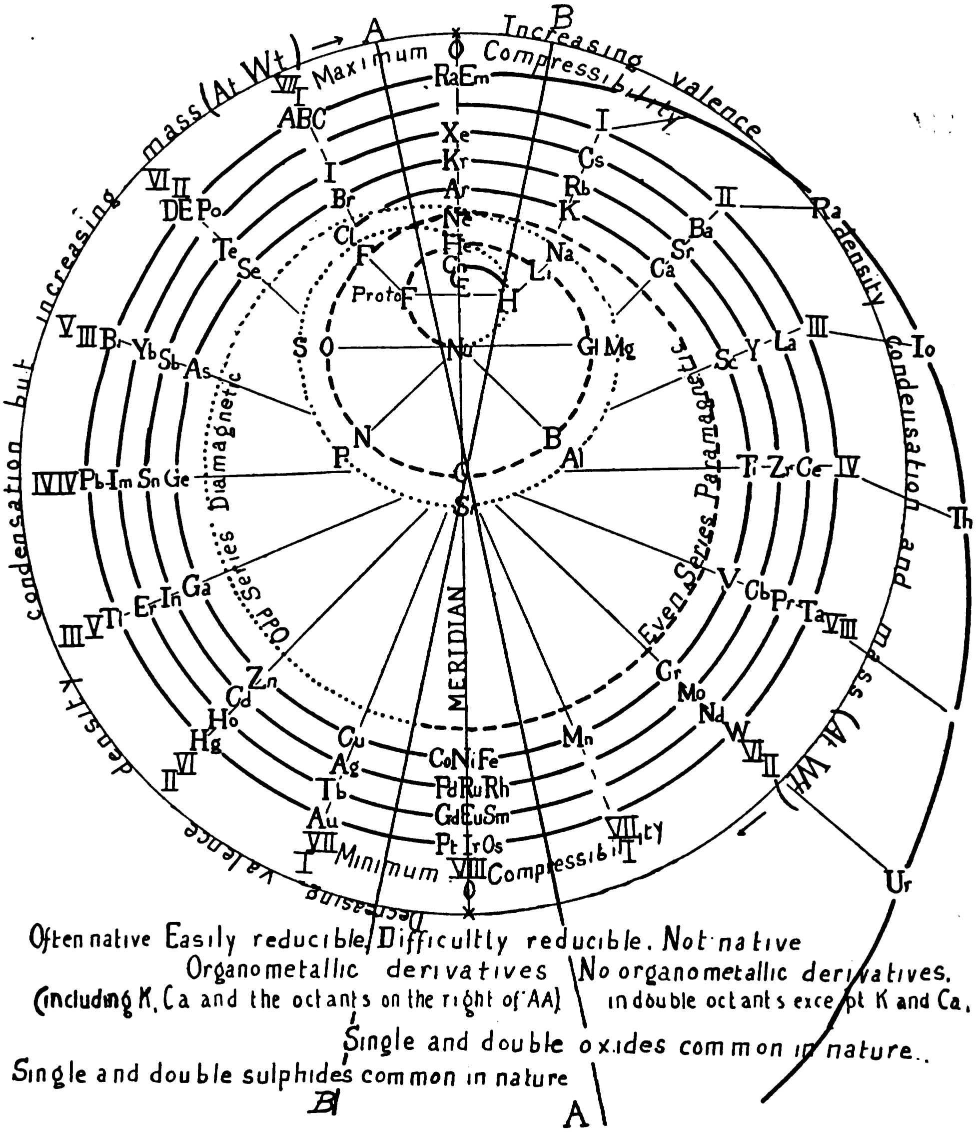


FIG. 3. Meridional Relations. Part of these relations are strictly meridional; part divide on the line *AA* which passes to the right of *C* and *Si*; part divide on the line *BB*, which passes between *C* and *Si*.

ranged along a narrow rising band the sulphur and halogen series rise along different and much steeper lines and drop to the common band when divided as suggested above.

The transverse relations may be diametral or symmetrical to a vertical diameter (Fig. 3) equatorial or symmetrical to a horizontal diameter (Fig. 4), and ecliptic or symmetrical to an oblique diameter (Fig. 5).

II. *Diametral Relations. Fig. 3*

A vertical diameter representing a vertical plane bisecting the helix divides the elements into two groups, which are for many relations the counterparts of each other, some exactly and some approximately. Each of these relations is placed on a separate ring—an arrow indicating the direction of increase, and a cross the points of change. It is curious that some of these relations are symmetrical to a line a little to the right of the diameter and passing between C and Si, and others to a line passing to the left of the diameter and to the right of C and Si. The only complex relations are those of the Mendeléeff series and the magnetic relations, which would seem more simple if the two octants were drawn as a single double octant. The most inexplicable of all these relations is expressed in the outer circle. As we pass down the right-hand curves an addition of 1, 2, 3 and 4 units (= H atoms) successively produces the same unit increase in valence and density and thus there is great condensation; going up on the left with the same increasing addition and thus with still increasing mass, there is lessening valence and density, and this contrast is repeated seven times.

III. *Equatorial Relations. Fig. 4*

The horizontal diameter makes very simple relationships, most of which are combined with the diametral relations in quadrantal arrangement. The valence may be a simple diametral relation or may increase to 4 and then decrease as an equatorial relation. The electro-potential relations are equatorial in so far as they are all strong above the horizontal line and weak below; quadrantal as far as the sign is concerned.

IV. *The Ecliptic Relations. Fig. 5*

The most important ecliptic relation is fusibility. On the one side are the high fusing elements, reaching a maximum fusing point at the end of an axis at right angles to the ecliptic. On the other side are the low fusing or volatile elements, reaching the maximum volatility at the end of the vertical axis. At one end of the ecliptic is the liquid mercury and at the other the luminous radium, while all the elements of the central most volatile quadrant, cut out of the volitile semi-circle by the equator and meridian, are absent from the sun, except these at the center, oxygen and nitrogen, the elements of the air.

Relations of Partial and Complex Symmetry. Fig. 6

The gas and rock areas show an antithesis which is only approximately an ecliptic relation. The gas area points upward and forward with the motion of the helix like a flame, and the rock area points downward and backward toward the center of the earth. The way the rocks and meteorites find orderly arrangement on this area from the light alkaline to the heavy ferric groups is very suggestive. The rock area typifies the increasing stability of the downward curves of increasing valence, density, and condensation. The gas area is its striking antithesis.

Attention may be called to the quadrilateral of life, CHON, in the center of the figure, surrounded by the elements on which life subordinately depends. These last are almost the only unsymmetrical relations.

A remarkable result is reached (in figures not reproduced here) by placing the elements on the helix in their true positions as determined by the real differences between successive elements rather than by the average differences for each type of circle. It is found that the agreement with the ideal position is much less perfect than might have been expected, and curious and unexpected symmetries come to light. It is further found that

the elements can be nearly as well placed on the curve by using the successive differences other, many elements in the first being as much too advanced as those in the other are

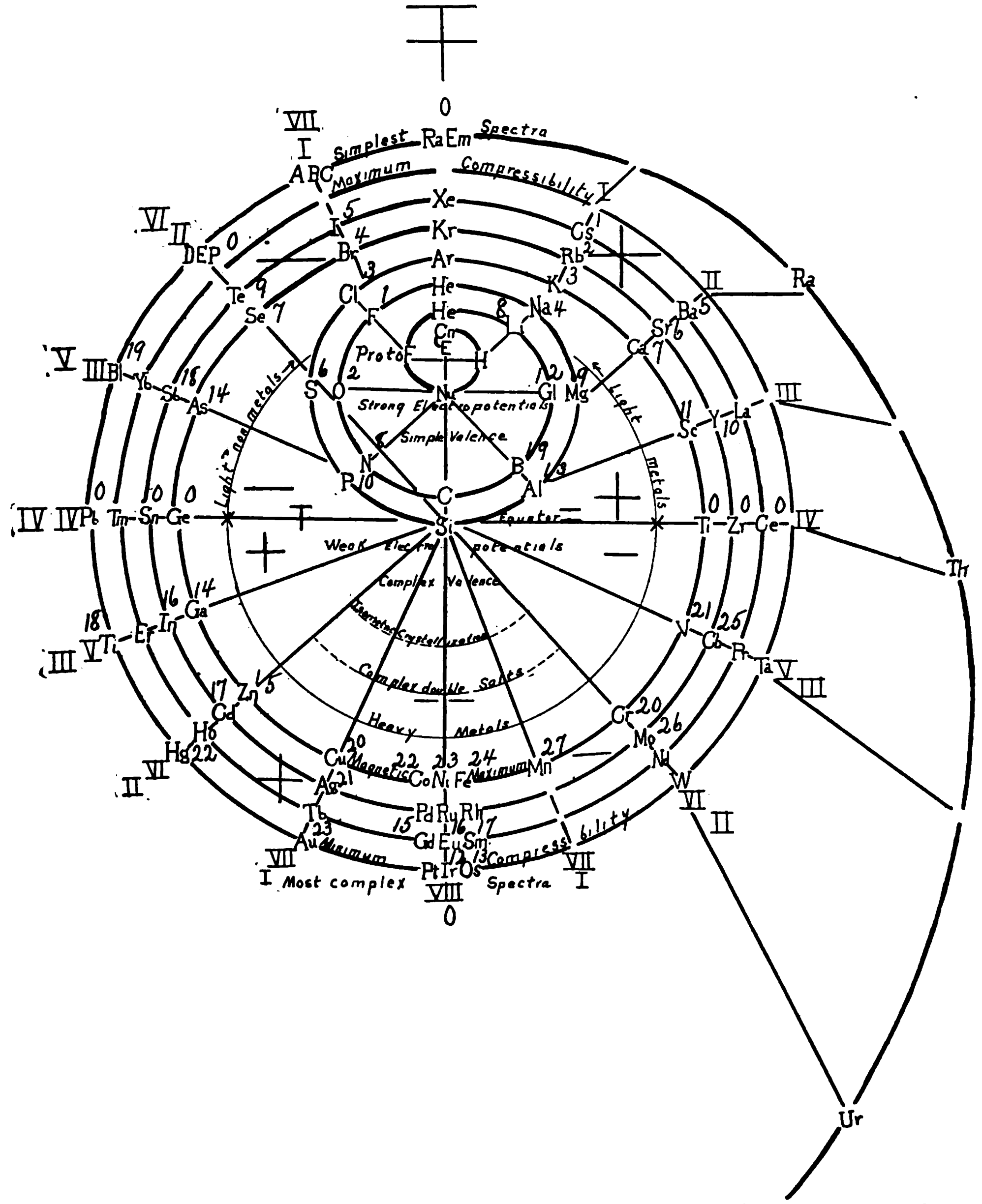


Fig. 4. Equatorial and Quadrantal Relations. Values of the electropotentials of the elements in detail. The printed numbers represent the order of these values, beginning with the highest. All the horizontal expressions refer to all the elements of the hemisphere in which they are placed.

of the densities, and that the inequalities of the two curves largely counterbalance each retarded. So that a table made by taking the average position indicated by the atomic

weight and the density differences brings the elements much nearer the true position. It is then inferred that the distance on the last curve by which each element is separated from its ideal position, taken with opposite sign, would represent the value of the remaining functions which influence the position of the elements. We must perhaps go back to the conditions of formation of the elements to find these values reduced to zero.

This brings into clear light the relative importance of valence, atomic weight, density and the ideal "position." The atomic weights have had a primary value in placing the elements nearly in that natural order, which has brought out their periodic or harmonic relations, and the suggestion of a "position" of ideal symmetry. It had something the value of a scaffolding to the completed building.

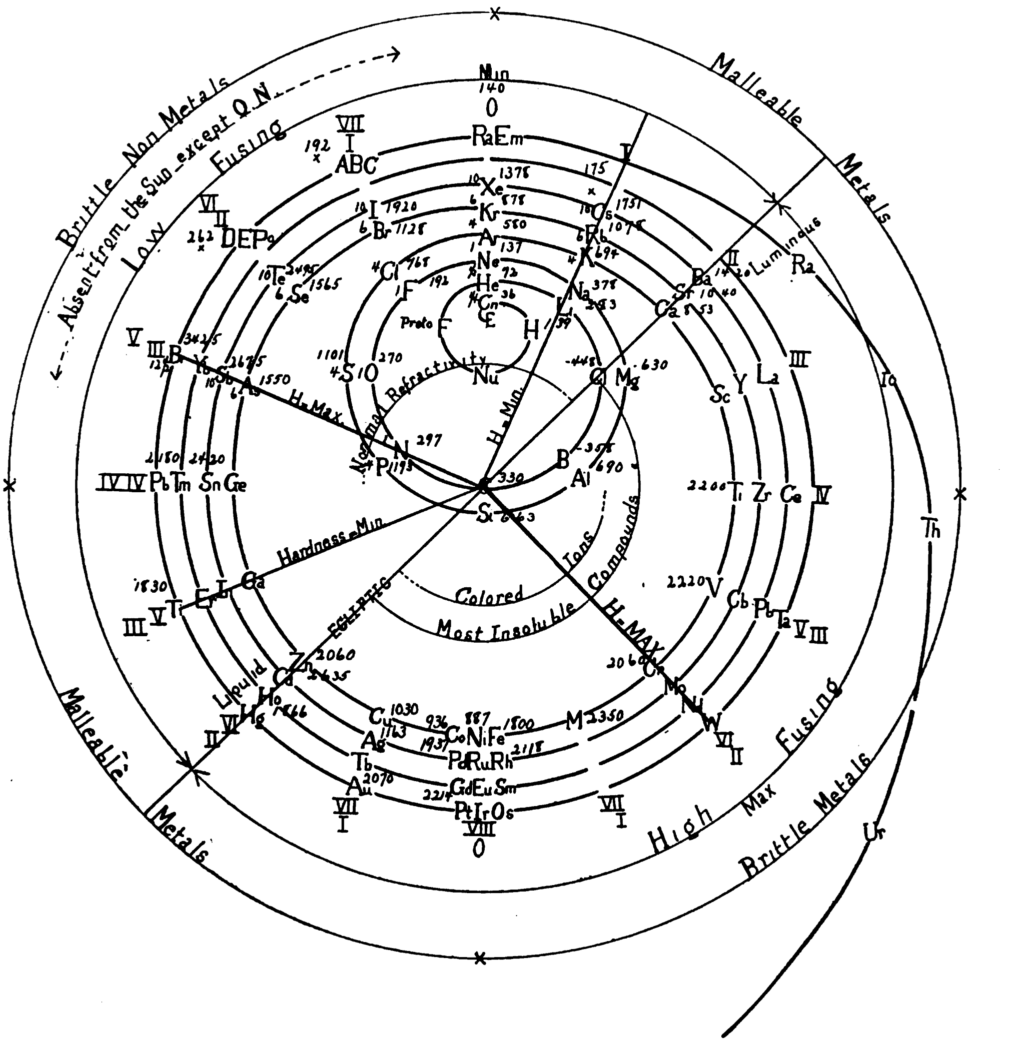


Fig. 5. Ecliptic Relations. Refractivity in detail. The large number on the right is the coefficient of refractivity. The small one on the left represents the factor to be multiplied into the constant at the border to obtain this refractivity.

3. *Evolution and Devolution*

The helix is a working model and it suggests that there is only one enduring stable

As the vix-generatrix passed over each unit space in the first circle the conditions favored the formation of a new element. In this cir-

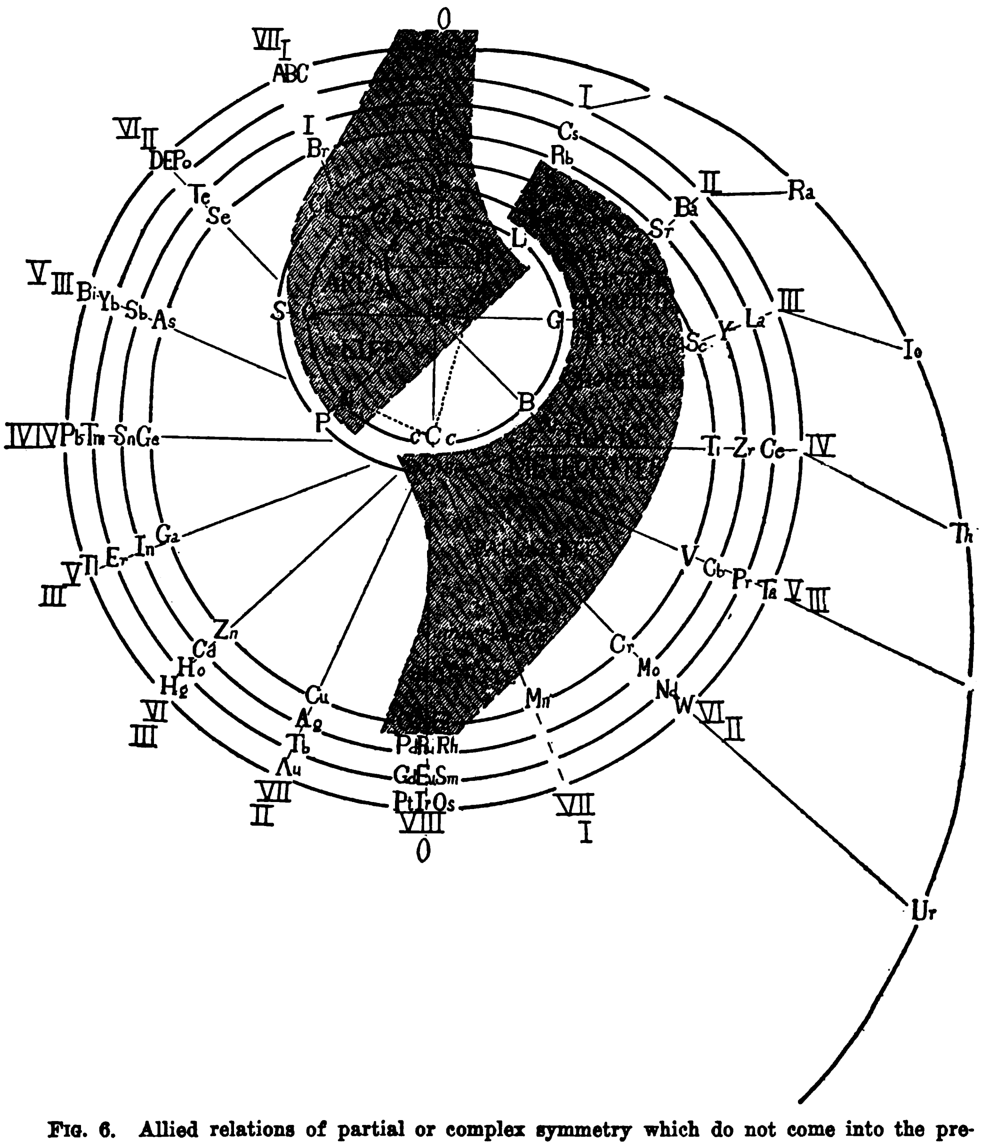


FIG. 6. Allied relations of partial or complex symmetry which do not come into the preceding categories. They are described in the section with which they are most nearly related.

assemblage of corpuscles between das Urstoff and hydrogen with its thousand corpuscles, and if that element be coronium, it has endured only under the exceptional conditions of the corona.

cle are the simplest forms of matter from hydrogen to helium. They appear abundantly in the nebulæ; existing and perhaps formed, near the absolute zero, where no heat vibrations could yet be predicated and where unex-

plained electrical activities could cause the light of the nebulæ. The helix prophesies the discovery of only one new element of low atomic weight, proto fluorine, and an intensified fluorine would naturally be a difficult element to capture.

On the completion of the first circle, a double momentum swelled the curve to a full octave, culminating in the unique element carbon, the element of life, and in a second octave culminating in silicon, the basis of the rocks. In contrast to the corpuscular temperature or vibration within the atom in the elements of the nebulæ, normal molecular vibration and normal electrical conditions became prevalent.

On passing potassium the treble momentum culminated in a double octave with the iron-nickel-cobalt group of the hot stars, the meteorites and the interior of the earth (see top of Fig. 1). One may surmise that most of the heavy elements beyond this group are unimportant in the mass of the earth as they are in the meteorites. A considerable molecular radiation may have been a condition precedent for the addition of a group of corpuscles equivalent to three hydrogen atoms, and the increasing complexity of the elements is indicated by their high and varying valence. Will three new elements be found to fill the gaps below Mn or will the outer triads be robbed for this purpose. The almost empty semicircle between *Yb* and *Ta* is tantalizing, but the helix would rule out the gathering of the "elements of the rare earths" into a group like the triads.

The sun carries the evolution a step further and it is conceivable that all the elements of the lowest-fusing quadrant have evaporated from it. Lead alone of the very heavy elements appears in the sun as a sort of calx or caput mortuum, suggesting that evaporation into helium has reached its limit there. It is remarkable that at the farthest place from this volatile quadrant, at the outermost curve of the high-fusing semi-circle, the radium elements should be evaporating with explosive heat and light-giving violence over all the surface of the earth: should exist in the outer layers of the earth only, and should be brought up by the light and highly acid pegmatite, whose quartz grains have been formed below 800°.[4] Becker's suggestion of the genesis of pegmatite with uranium as a potentializer of the energy that must escape in its formation is most interesting.[5]

When the assemblages had become so complex that devolution began to prevail over evolution the size of the added group of corpuscles increased to four, and a short advance only was made along the first quadruple-octave ring.

If ink is allowed to flow from a dropping tube, the point of which is immersed in water in a tall glass, the descending stream soon forms vortex rings and, as these rings sink and expand, they often become scalloped at the edges and the scallops expand in lobes which separate in distinct subordinate vortex rings while the central part closes in as an almost perfect ring again. Sometimes several of these lobes will separate symmetrically at the same time like the fluting on the border of a rose leaf. This is a model of the radium emanations and of the breaking up of the complex atoms. Thus is the limit set to the complexity of the atom and the length of the helix.

It has a mystical attractiveness that the helix has a shape like the spiral nebula from which all things have been thought to originate, and toward which they again tend, and that the tetrahedral element carbon stands in the center of this helix and by its shapes (ranging from the tetrahedron which includes the smallest amount of matter in unit surface almost to the sphere which contains the largest amount of matter in unit surface) typifies the infinite possibilities of life of which it is the vehicle and embodies the tetrahedral form which the earth has repeatedly if imperfectly assumed.[6]

B. K. Emerson

[4] Day and Shepard, *Am. Jour. Sc.*, Vol. XX., p. 276, 1906.

[5] G. F. Becker, "Radioactivity and Cosmogony," *Bull. Geo. Soc.*, Vol. 19, p. 143.

[6] T. Arldt, "Die Entwicklung der Erde," p. 506, 1907.

SCIENCE

FRIDAY, NOVEMBER 17, 1911

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE RÔLE OF SALTS IN THE PRESERVATION OF LIFE[1]

I

LESS is known of the rôle of the salts in the animal body than of the rôle of the three other main food-stuffs, namely, carbohydrates, fats and proteins. As far as the latter are concerned, we know at least that through oxidation they are capable of furnishing heat and other forms of energy. The neutral salts, however, are not oxidizable. Yet it seems to be a fact that no animal can live on an ash-free diet for any length of time, although no one can say why this should be so. We have a point of attack for the investigation of the rôle of the salts in the fact that the cells of our body live longest in a liquid which contains the three salts, NaCl, KCl and $CaCl_2$ in a definite proportion, namely, 100 molecules NaCl, 2.2 molecules KCl and 1.5 molecules of $CaCl_2$. This proportion is identical with the proportion in which these salts are contained in sea-water; but the concentration of the three salts is not the same in both cases. It is about three times as high in the sea-water as in our blood serum.

Biologists have long been aware of the fact that the ocean has an incomparably richer fauna than fresh-water lakes or streams and it is often assumed that life on our planet originated in the ocean. The fact that the salts of Na, Ca and K exist in the same proportion in our blood serum as in the ocean has led some authors to the conclusion that our ancestors were marine

[1] Carpenter lecture delivered at the Academy of Medicine of New York, October 19, 1911.

animals, and that, as a kind of inheritance, we still carry diluted sea-water in our blood. Statements of this kind have mainly a metaphorical value, but they serve to emphasize the two facts, that the three salts, NaCl, KCl and $CaCl_2$, exist in our blood in the same relative proportion as in the ocean and that they seem to play an important rôle in the maintenance of life.

I intend to put before you a series of experiments which seem to throw some light on the mechanism by which the solutions surrounding living cells influence their duration of life.

II

In order to give a picture of the extent to which the life of many animals depends upon the cooperation of the three salts I may mention experiments made on a small marine crustacean, *Gammarus,* of the Bay of San Francisco. If these animals are suddenly thrown into distilled water, their respiration stops (at a temperature of 20° C.) in about half an hour. If they are put back immediately after the cessation of respiration into sea-water, they can recuperate. If ten minutes or more are allowed to elapse before bringing them back into the sea-water, no recuperation is possible. Since in this case death is caused obviously through the entrance of distilled water into the tissues of the animals, one would expect that the deadly effect of distilled water would be inhibited if enough cane sugar were added to the distilled water to make the osmotic pressure of the solution equal to that of the sea-water. If, however, the animals are put into cane-sugar solution, the osmotic pressure of which is equal to that of sea-water, the animals die just about as rapidly as in distilled water. The same is true if the osmotic pressure of the sugar solution is higher or lower than that of the sea-water. The sugar solution is, therefore, about as toxic for the animals as the distilled water, although in the latter case water enters into the tissues of the animal, while in the former case it does not.

If the sea-water is diluted with an equal quantity of distilled water in one case, and of isotonic cane-sugar solution in the other case, in both cases the duration of life is shortened by practically the same amount.

If the crustaceans are brought into a pure solution of NaCl, of the same osmotic pressure as the sea-water, they also die in about half an hour. If to this solution a little calcium chloride be added in the sea-water the animals die as rapidly as proportion in which it is contained in the without it. If, however, both $CaCl_2$ *and* KCl are added to the sodium chloride solution, the animals can live for several days. The addition of KCl alone to the NaCl prolongs their life but little.

If KCl and $CaCl_2$ are added to a cane sugar solution isotonic with sea-water, the animals die as quickly or more so than in the pure cane-sugar solution.

If other salts be substituted for the three salts the animals die. The only substitution possible is that of $SrCl_2$ for $CaCl_2$. We find also that the proportion in which the three salts of sodium, calcium and potassium have to exist in the solution can not be altered to any extent. All this leads us to the conclusion, that in order to preserve the life of the crustacean *Gammarus,* the solution must not only have a definite concentration or osmotic pressure but that this osmotic pressure must be furnished by definite salts, namely, sodium chloride, calcium chloride and potassium chloride in the proportion in which these three salts exist in the sea-water (and in the blood); this fact could also be demonstrated for many other marine animals.

The relative tolerance of various cells and animals for abnormal salt solutions is, however, not the same, a point which we shall discuss later on.

III

What is the rôle of the salts in these cases? The botanists have always considered salt solutions as nutritive solutions. It is a well-known fact that plants require definite salts, *e. g.*, nitrates and potassium salts, for their nutrition, and the question now arises whether the three salts NaCl, KCl and $CaCl_2$, which are needed for the preservation of animal life, play the rôle of nutritive salts. Experiments which I made on a small marine fish, *Fundulus*, proved beyond question that this is not the case. If the young, newly hatched fish are put into a pure solution of sodium chloride of the concentration in which this salt is contained in sea-water, the animals very soon die. If, however, KCl and $CaCl_2$ be added to the solution in the right proportion, the animals can live indefinitely. These fish, therefore, behave in this respect like *Gammarus* and the tissues of the higher animals, but they differ from *Gammarus* and the majority of marine animals inasmuch as the fish can live long, and in some cases, indefinitely, in distilled and fresh water, and certainly in a very dilute solution of sodium chloride. From this fact I drew the conclusion that KCl and $CaCl_2$ do not act as nutritive substances for these animals, that they only serve to render NaCl harmless if the concentration of the latter salt is too high. I succeed in showing that as long as the sodium-chloride solution is very dilute and does not exceed the concentration of m./8, the addition of KCl and $CaCl_2$ is not required. Only when the solution of NaCl has a concentration above m./8 does it become harmful and does it require the addition of KCl and $CaCl_2$.

The experiments on *Fundulus*, therefore, prove that a mixture of NaCl + KCl + $CaCl_2$ does not act as a nutritive solution, but as a *protective* solution. KCl and $CaCl_2$ are only necessary in order to prevent the harmful effects which NaCl produces if it is alone in solution and if its concentration is too high. We are dealing, in other words, with a case of antagonistic salt action; an antagonism between NaCl on the one hand and KCl and $CaCl_2$ on the other. The discovery of antagonistic salt action was made by Ringer, who found that there is a certain antagonism between K and Ca in the action of the heart. When he put the heart of a frog into a mixture of NaCl + KCl he found that the contractions of the heart were not normal, but they were rendered normal by the addition of a little $CaCl_2$. A mixture of NaCl + $CaCl_2$ also caused abnormal contractions of the heart, but these were rendered normal by the addition of KCl. Ringer drew the conclusion that there existed an antagonism between potassium and calcium, similar to that which Schmiedeberg had found between different heart poisons, *e. g.*, atropin and muscarin. Biedermann had found that alkaline salt solutions cause twitchings in the muscle and Ringer found that the addition of Ca inhibited these twitchings. Since these experiments were made many examples of the antagonistic action of salts have become known.

It had generally been assumed that the antagonistic action of two salts was based on the fact that each salt, when applied singly, acted in the opposite way from that of its antagonist. We shall see that in certain cases of antagonistic salt action at least this view is not supported by fact.

IV

What is the mechanism of antagonistic salt action? I believe that an answer to

this question lies in the following observations on the *eggs* of *Fundulus*. If these eggs are put immediately after fertilization into a pure sodium chloride solution which is isotonic with sea-water, they usually die without forming an embryo. If, however, only a trace of a calcium salt, or of any other salt with a bivalent metal (with the exception of Hg, Cu or Ag) is added to the m./2 NaCl solution, the toxicity of the solution is diminished or even abolished. Even salts which are very poisonous, namely, salts of Ba, Zn, Pb, Ko, Ni, Mn and other bivalent metals, are able to render the pure solution of sodium chloride harmless, at least to the extent that the eggs can live long enough to form an embryo. The fact that a substance as poisonous as Zn or lead can render harmless a substance as indifferent as sodium chloride seemed so paradoxical that it demanded an explanation, and this explanation casts light on the nature of the protective or antagonistic action of salts. For the antagonistic action of a salt of lead or zinc against the toxic action of sodium chloride can only consists in the lead salt protecting the embryo against the toxic action of the NaCl. But how is this protective action possible?

We have mentioned that if we put the young fish, immediately after hatching, into a pure m./2 solution of sodium chloride the animals die very quickly, but that they live indefinitely in the sodium chloride solution if we add both $CaCl_2$ and KCl. How does it happen that for the embryo, *as long as it is in the egg shell,* the addition of $CaCl_2$ to the NaCl solution suffices, while if the fish is *out of the shell* the addition of $CaCl_2$ alone is no longer sufficient and the addition of KCl also becomes necessary? Moreover, if we try to preserve the life of the fish *after it is taken out of the egg* in an m./2 sodium chloride solution by adding $ZnSO_4$, or lead acetate, to the solution we find that the fish die even much more quickly than without the addition.

If we look for the cause of this difference our attention is called to the fact that the fish, as long as it is in the egg, is separated from the surrounding solution by the egg membrane. This egg membrane possesses a small opening, the so-called micropyle, through which the spermatozoon enters into the egg. I have gained the impression that this micropyle is not closed as tightly immediately after fertilization as later on, since the *newly fertilized* egg is killed more rapidly by an m./2 solution of NaCl than it is killed by the same solution one or two days after fertilization. One can imagine that the micropyle contains a wad of a colloidal substance which is hardened gradually to a leathery consistency if the egg remains in the sea-water. With the process of hardening, or tanning, it becomes more impermeable for the NaCl solution. This process of hardening is brought about apparently very rapidly if we add to the m./2 NaCl solution a trace of a salt of a bivalent metal like Ca, Sr, Ba, Zn, Pb, Mn, Ko and Ni, etc. It is also possible that similar changes take place in the whole membrane. The process of rendering the m./2 Na solution harmless for the embryo of the fish, therefore, depends apparently upon the fact that the addition of the bivalent metals render the micropyle or perhaps the whole membrane of the egg more impermeable to NaCl than was the case before.

But these are only one part of the facts which throw a light upon the protective or antagonistic action of salts. Further data are furnished by experiments which I made together with Professor Gies, also on the eggs of *Fundulus*. Gies and I were able to show that not only are the bivalent metals able to render the sodium chloride solution harmless, but that the reverse is also the

case, namely, that NaCl is required to render the solutions of many of the bivalent metals, for instance $ZnSO_4$, harmless. (That the SO_4 ion has nothing to do with the result was shown before by experiments with Na_2SO_4.)

If the eggs of *Fundulus* are put immediately after fertilization into distilled water, a large percentage of the eggs develop, often as many as one hundred per cent., and the larvæ and embryos formed in the distilled water are able to hatch. If we add, however, to 100 c.c. of distilled water that quantity of $ZnSO_4$ which is required to render the NaCl solution harmless, all the eggs are killed rapidly and not a single one is able to form an embryo. If we add varying amounts of NaCl we find that, beginning with a certain concentration of NaCl, this salt inhibits the toxic effects of $ZnSO_4$ and many eggs are able to form an embryo. This can be illustrated by the following table.

TABLE I

Nature of the Solution	Percentage of the Eggs Forming an Embryo
100 c.c. distilled water	49
100 c.c. distilled water +8 c.c. m./32 $ZnSO_4$	0
100 c.c. m./64 NaCl+8 c.c. m./32 $ZnSO_4$	0
100 c.c. m./32 NaCl+8 c.c. m./32 $ZnSO_4$	3
100 c.c. m./16 NaCl+8 c.c. m./32 $ZnSO_4$	8
100 c.c. m./8 NaCl+8 c.c. m./32 $ZnSO_4$	44
100 c.c. m./4 NaCl+8 c.c. m./32 $ZnSO_4$	38
100 c.c. 3/8 NaCl+8 c.c. m./32 $ZnSO_4$	37
100 c.c. m./2 NaCl+8 c.c. m./32 $ZnSO_4$	34
100 c.c. 5/8 NaCl+8 c.c. m./32 $ZnSO_4$	29
100 c.c. 6/8 NaCl+8 c.c. m./32 $ZnSO_4$	8
100 c.c. 7/8 NaCl+8 c.c. m./32 $ZnSO_4$	6
100 c.c. m. NaCl+8 c.c. m./32 $ZnSO_4$	1

This table shows that the addition of NaCl, if its concentration exceeds a certain limit, namely, m./8, is able to render the $ZnSO_4$ in the solution comparatively harmless.

If we now assume that $ZnSO_4$ renders the 5/8 m. NaCl solution harmless by rendering the egg membrane comparatively impermeable for NaCl we must also draw the opposite conclusion, namely, that NaCl renders the egg membrane comparatively impermeable for $ZnSO_4$. We, therefore, arrive at a new conception of the mutual antagonism of two salts, namely, that this antagonism depends, in this case at least, upon a *common, cooperative* action of *both* salts on the egg membrane, by which action this membrane becomes completely or comparatively impermeable for *both* salts. And from this we must draw the further conclusion that the fact that each of these salts, if it is alone in the solution, is toxic, is due to its comparatively rapid diffusion through the membrane, so that it comes into direct contact with the protoplasm of the germ.

As long as we assumed that each of the two antagonistic salts acted, if applied singly, in the opposite way from its antagonist, it was impossible to understand these experiments or find an analogue for them in colloid chemistry. But if we realize that NaCl alone is toxic because it is not able to render the egg membrane impermeable; and that $ZnSO_4$ if alone in solution is toxic for the same reason; while both combined are harmless (since for the "tanning" of the membrane the action of the two salts is required) these experiments become clear.

We may, for the sake of completeness, still mention that salts alone have such antagonistic effects; glycerine, urea and alcohol have no such action. On the other hand, $ZnSO_4$ was not only able to render NaCl harmless, but also LiCl, NH_4Cl, $CaCl_2$ and others; and *vice versa*.

These experiments on the egg of *Fundulus* are theoretically of importance, since they leave no doubt that in this case at least the "antagonistic" action of salts consists in a modification of the egg membrane

by a combined action of two salts, whereby the membrane becomes less permeable for both salts.

V

It is not easy to find examples of experiments in the literature which are equally unequivocal in regard to the character of antagonistic salt action; but I think that some recent experiments by Osterhout satisfy this demand.

It has long been a question whether or not cells are at all permeable for salts. Nobody denies that salts diffuse much more slowly into the cells than water; but some authors, especially Overton and Hoeber, deny categorically that salts can diffuse at all into the cells. Overton's view is based partly on experiments on plasmolysis in the cells of plants. If the cells of plants, for example, those of *Spirogyra*, are put into a solution of NaCl or some other salt of sufficiently high osmotic pressure, the volume of the contents of the cell decreases through loss of water and the protoplasm retracts, especially from corners of the rigid cellulose walls. Overton maintains that this plasmolysis is permanent, and concludes from this that only water but no salt, can diffuse through the cell-wall; since otherwise salts should gradually diffuse from the solution into the cell, and through this increase in the osmotic pressure of the cell the water should finally diffuse back into the cell and restitute the normal volume of the cell. According to Overton this does not happen.

Osterhout has recently shown that Overton's observations were incomplete in a very essential point and that in reality the plasmolysis, which occurs in this case when the cell is put into the hypertonic solution, disappears again in a time which varies with the nature of the salt in solution. This stage of reversion of plasmolysis had been overlooked by Overton. If the cell, however, remains permanently in the hypertonic sodium chloride solution, afterwards again a shrinking of the contents of the cell takes place, which superficially resembles plasmolysis, but which in reality has nothing to do with plasmolysis, but is a phenomenon of death. That this second "false plasmolysis," as Osterhout calls it, has nothing to do with the hypertonic character of the solution was proved by the fact that hypotonic solutions of toxic substances may produce the same phenomenon.

In one experiment which Osterhout describes, "a portion of a *Spirogyra* filament was plasmolyzed in .2 m. $CaCl_2$, but not in .195 m. $CaCl_2$. A .29 m. NaCl solution has approximately the same osmotic pressure as a .2 m. $CaCl_2$ solution. But on placing another portion of the same *Spirogyra* filament in a .29 m. NaCl solution the expected plasmolysis does not occur and it is impossible to plasmolyze the cells until they are placed in .4 m. NaCl." Osterhout explains this difference in the concentration of the two salts required for plasmolysis by the assumption that NaCl diffuses more rapidly into the cell than $CaCl_2$, a conclusion which I reached also on the basis of my earlier experiments on animals.

Osterhout's experiments also show that the antagonism of NaCl and $CaCl_2$ depends partly on the facts that the two salts inhibit each other from diffusing into the cells, and this conclusion is based among others upon the following experiment. "By dividing a *Spirogyra* filament into several portions it was found that it was plasmolyzed in .2 m. $CaCl_2$ and in .38 m. NaCl, but neither in .195 m. $CaCl_2$ nor in .375 m. NaCl. On mixing 100 c.c. .375 m. NaCl with 10 c.c. .195 m. $CaCl_2$ and placing other portions of the same filament in it, prompt and very marked plasmolysis occurred."

The explanation for this observation lies

in the fact that in the mixture of NaCl and $CaCl_2$ the two salts render their diffusion into the cell mutually more difficult. After a longer period of time the plasmolyzed cells can expand again in a mixture of NaCl and $CaCl_2$, but that occurs much later than if they are in the pure NaCl solution.

These experiments are the analogue of the observation on the embryo of the eggs of *Fundulus* in which a pure solution of $ZnSO_4$ diffused rapidly through the membrane or micropyle, while, if both salts were present, the diffusion was inhibited or considerably retarded.

While the observations of Osterhout show that Overton was not justified in using the experiments on plasmolysis to prove that the neutral salts can not diffuse into the cells, yet they do not prove that these salts diffuse into the cell under normal conditions. In Osterhout's experiments the cells are in strongly hypertonic solutions and it does not follow that such solutions act like isotonic, perfectly balanced solutions.

VI

Wasteneys and I have recently shown that the toxic action of acids upon *Fundulus* can be annihilated by salts. If we add 0.5 c.c. $N/10$ butyric acid to 100 c.c. of distilled water these fish die in 2½ hours or less. In solutions which contain 0.4 c.c. or less acid they can live for a week or more. If we add, however, 0.5 c.c. of butyric acid to 100 c.c. of solutions of NaCl of various concentration, we find that above a certain limit the NaCl can render the acid harmless. It is needless to say that the NaCl used in these experiments was strictly neutral and that the amount of acid present in the mixture of acid and salt was measured. The following experiment may serve as an example.

TABLE II

After	Number of Surviving Fish in 0.5 c.c. $N/10$ Butyric Acid						
	+0	4.0	6.0	8.0	10.0	12.0	15.0
	c.c. m./2 NaCl in 100 c.c. of the Solution						
2 hours	0	0	0	2	3	3	6
4 hours				0	3	2	5
1 day					1	1	5
2 days					1	0	5
3 days					1		5
4 days					1		5

If the amount of acid was increased, the amount of NaCl also had to be increased to render the acid harmless. In order to render 0.5 c.c. $N/10$ butyric acid pro 100 c.c. solution harmless, 10 c.c. m./2 NaCl had to be added; while 0.8 c.c. butyric acid required 20 c.c. and 1.0 c.c. butyric acid required about 28 c.c. m./2 NaCl in 100 c.c. of the solution.

Not only butyric acid, but any kind of acid, could be rendered harmless by neutral salts, *e. g.*, HCl by NaCl.

It is of great importance that the antagonistic action of $CaCl_2$ was found to be from 8 to 11 times as great or powerful as the action of NaCl. This harmonizes with the general observation that the protective action of $CaCl_2$ for the life of cells is greater than that of any other substance.

Wasteneys and I could show that the rate of the absorption of acid by the fish is the same in solutions with and without salt. This proves that the action of the salts consisted in this case not in preventing the diffusion or absorption of the acid, but in modifying the deleterious effect of the absorbed acid.

We can state a little more definitely the cause of death by acid. If we put the fish into a weak acid solution in distilled water just strong enough to kill the fish in from 1 to 2 hours (*e. g.*, 500 c.c. $H_2O + 2.0$ c.c. $N/10$ HCl), we notice that the acid very soon makes the normally transparent epidermis of the fish opaque, and a little later the epidermis falls off in pieces and shreds.

This, however, is probably not the direct cause of the death, but I am inclined to assume that the fish die from suffocation caused by a similar action of the acid upon the gills.

The action of the acid upon the epidermis of the body as well as upon the gills is prevented through the addition of neutral salts.

It is well known that the action of acids upon proteins can be inhibited by neutral salts. Thus the internal friction of certain protein solutions is increased by acids while the addition of neutral salts inhibits this effect (Pauli). The swelling of gelatine caused by acid is inhibited by salts (Procter).

It is possible that in the experiments with acid the fish is killed in the following way. The acid causes certain proteins in the surface layer of the epithelial cells of the gills and of the skin to swell, whereby this surface layer becomes more permeable for the acid. The acid can now diffuse into the epithelial cells and act on the protoplasm, whereby the cells are killed. If salts are present in the right concentration, the combined action of acid and salt causes a dehydration of the surface film of these cells, as it does in the experiments on gelatine or as in the cases of tanning of hides by the combined action of acids and salt solutions. This combined dehydrating or "tanning" action of acid and salts on the surface of the epithelial cells of the gills diminishes the permeability of this layer for the acids and prevents them from diffusing into the cells and thus destroying the protoplasm. In this way the gills are kept intact and the life of the fish is saved.

As long as the amount of acid is small the amount absorbed is not essentially diminished by the presence of salts; but while in the presence of salts the acid is consumed in the tanning action of the surface layer of the cells, or is absorbed in this layer; if no salt is present part of the acid diffuses into the epithelial cells and kills the latter.

VII

We have thus far considered the cases of antagonism between two electrolytes only. The case of the antagonism between three electrolytes is a little more complicated.

We choose as an example the antagonism between NaCl, KCl and $CaCl_2$—the antagonism which is most important in life phenomena. If the mechanism of the antagonism between NaCl, on the one hand, and KCl and $CaCl_2$, on the other, is of the same nature as that between NaCl and $ZnSO_4$ in the case of the eggs of *Fundulus*, it must be possible to show that not only is NaCl toxic if it is alone in solution, and that it is rendered harmless by the two other salts, but that the reverse is true also. This can be proved in the case of KCl. To demonstrate it, we have again to experiment on organisms which are, in wide limits, independent of the osmotic pressure of the surrounding solution since the concentration of the KCl in sea-water is very low. The experiments were carried out by Mr. Wasteneys and myself on *Fundulus*. The method consisted in putting six fish, after washing them twice with distilled water, into 500 c.c. of the solution. It was ascertained from day to day how many fish survived.

When the fish were put into pure solutions of KCl of the concentration in which this salt is contained in the sea-water (2.2 c.c. m./2 KCl in 100 c.c. of the solution) they died mostly in less than two days. This is not due to the low concentration of the KCl solution, which is only 1/50 of that of the sea-water, since the fish can live indefinitely in a pure NaCl solution of the same concentration as that in which the KCl exists in the sea-water.

If we add to the toxic quantities of KCl increasing quantities of NaCl, we find that

as soon as the solution contains 17 or more molecules of NaCl to one molecule of KCl, the toxic action of KCl is considerably diminished, if not completely counteracted. The following table may serve as an example.

TABLE III

After Days	Number of Surviving Fish in 2.2 c.c. m./2 KCl in 100 c.c.							
	H_2O	m./100	m./20	m./8	m./4	3 m./8	m./2	NaCl
1	2	1	3	4	6	6	6	
2	0	0	0	0	6	5	6	
3					6	4	6	
4					5	3	5	
5					5	3	4	
6					5	3	1	
7					5	3	0	
14					4	3		

More accurate determinations showed that already a 3/16 m. NaCl solution renders the solution of 2.2 c.c. m./2 KCl in 100 c.c. of the solution harmless.

It was next determined whether different concentrations of KCl required different concentrations of NaCl. It was found that the coefficient of antagonization KCl/NaCl has an approximately constant value, namely, about 1/17, as the following table shows.

TABLE IV

	Coefficient of Antagonization
0.6 c.c. m./2 KCl rendered harmless in 100 c.c. 3/64 m. NaCl	1/16
0.7 c.c. m./2 KCl rendered harmless in 100 c.c. 4/64 m. NaCl	1/18
0.9 c.c. m./2 KCl rendered harmless in 100 c.c. 5/64 m. NaCl	1/17
1.0 c.c. m./2 KCl rendered harmless in 100 c.c. 5/64–6/64 m. NaCl	1/16–1/19
1.1 c.c. m./2 KCl rendered harmless in 100 c.c. 6/64 m. NaCl	1/17
1.65 c.c. m./2 KCl rendered harmless in 100 c.c. 5/32 m. NaCl	1/19
2.2 c.c. m./2 KCl rendered harmless in 100 c.c. 6/32 m. NaCl	1/17
2.75 c.c. m./2 KCl rendered harmless in 100 c.c. 7/32 m. NaCl	1/16
3.3 c.c. m./2 KCl rendered harmless in 100 c.c. 9/32 m. NaCl	1/17

What happens if we vary this ratio? If we add too little NaCl to the KCl solution, namely, only 1 to 10 molecules NaCl to 1 molecule of KCl, the solution becomes more harmful than if KCl is alone in solution; if we add considerably more than 17 molecules NaCl, *e. g.*, 50 molecules to one molecule of KCl, the solution becomes toxic again; and the more so the higher the concentration of NaCl. This indicates that the antagonistic effect requires a rather definite ratio of the two salts. This furnishes the reason why an m./2 solution can, as a rule, not be rendered completely harmless by the mere addition of KCl, but that in addition $CaCl_2$ is needed.

If we add to 100 c.c. m./2 NaCl enough KCl to make the ratio KCl : NaCl = 1/17 we find that the antagonization of KCl : NaCl becomes incomplete. If the amount of KCl in 100 c.c. of the solution exceeds 2.2 c.c. m./2 KCl, antagonization is still to some extent possible, but it becomes more incomplete the higher the concentration of KCl. For this reason it is not possible to render an m./2 solution of NaCl harmless by the mere addition of KCl.

$CaCl_2$ acts upon KCl similarly as does NaCl, but it acts more powerfully; *i. e.*, the coefficient of antagonization, $KCl/CaCl_2$, is several hundred or a thousand times as great as that of KCl/NaCl, as the following table shows.

TABLE V

	Coefficient of Antagonization $KCl/CaCl_2$
1.1 c.c. m./2 KCl in 100 c.c. H_2O require 0.1 m./100 $CaCl_2$ ..	550
1.65 c.c. m./2 KCl in 100 c.c. H_2O require 0.5 m./100 $CaCl_2$ ..	165
2.2 c.c. m./2 KCl in 100 c.c. H_2O require 0.3 m./100 $CaCl_2$ ..	366
2.75 c.c. m./2 KCl in 100 c.c. H_2O require 1.0 m./100 $CaCl_2$ ..	137.5
3.3 c.c. m./2 KCl in 100 c.c. H_2O require 1.6 m./100 $CaCl_2$ ..	103

The coefficients are not as regular as in the case of antagonization of KCl by NaCl. This is due to the fact that the minimal value of $CaCl_2$ at which it renders the KCl harmless can not be determined as sharply as the limit for NaCl. Why is less $CaCl_2$ required than NaCl? We can only answer with a suggestion first offered by T. B. Robertson, namely, that $CaCl_2$ produces its protective effect through the formation of a comparatively insoluble compound (in this case on the gills or the rest of the surface of the animal) while NaCl acts through the formation of a compound which is more soluble. This view is corroborated by the observation which we made, that Sr is just as effective to antagonize KCl as $CaCl_2$, but that Mg is much less efficient. This would correspond with the well-known fact that many strontium salts are just as insoluble, if not more insoluble, than the calcium salts, while the magnesium salts are often incomparably more soluble, for instance in the case of the sulphates. $BaCl_2$ antagonizes KCl also powerfully, but, probably, in consequence of the fact that the substances formed at the surface of the animal or the gills, diffuse slowly into the cells, the fish do not remain alive as long if Ba is used as if the more harmless Ca and Sr are used.

It is very remarkable that $CaCl_2$ renders harmless any given concentration of KCl below 6.6 c.c. m./2 KCl in 100 c.c. of the solution, but not above this limit. This limit is exactly the same which we found in the case of antagonization of KCl by NaCl. Even the combination of NaCl and $CaCl_2$ does not permit us to render harmless more than 6.6 c.c. m./2 KCl in 100 c.c. of the solution.

If we try to render NaCl harmless by KCl and $CaCl_2$ we find that $CaCl_2$ can antagonize even a 6/8 m. and a 7/8 m. solution of NaCl, while KCl ceases to show any antagonistic effect if the NaCl solution exceeds m./2 or 5/8 m.

Experiments with pure $CaCl_2$ solutions give the result that this substance is harmless in a solution of that concentration in which this salt is contained in the sea-water. *Fundulus* can live indefinitely in a solution of 1.5 c.c. m./2 $CaCl_2$ in 100 c.c. Botanists have also found that weak solutions of $CaCl_2$ are comparatively little toxic. This gives us the impression that the effect upon the surface film of protoplasm produced by $CaCl_2$ is especially important for the protection of the protoplasm. This conclusion receives an indirect support by the well-known experiments of Herbst, who found that in sea-water deprived of calcium the segmentation cells of a sea-urchin embryo fall apart through the disintegration or liquefaction of a film which surrounds the embryo and keeps the cells together. If such eggs are brought back into solution containing calcium the film is restored and the cells come into close contact again.

It is therefore not impossible that the mechanism of the antagonism between KCl and NaCl is similar to that found between NaCl and $ZnSo_4$. It seems only due to the high concentration of the NaCl in the sea-water and in the blood that, in addition to KCl and NaCl, $CaCl_2$ is needed. But the case is not so unequivocal as the previously mentioned cases of antagonism between only two electrolytes.

VIII

It is necessary for our understanding of the life-preserving action of salts that we do not depend merely on *conclusions* drawn from experiments, but that we must be able to see directly in which way abnormal salt solutions cause the death of the cell. Such

an opportunity is offered us through the observation of the eggs of the sea-urchin. If we put the fertilized eggs of the sea-urchin into an abnormal salt solution, a destruction of the cell gradually takes place. The destruction, as a rule, begins on the surface of the protoplasm, and consists very often in the formation and falling off of small granules or droplets. This process gradually continues from the periphery towards the center until the whole egg is disintegrated. For different salt solutions the picture of the disintegration is a little different, but sufficiently characteristic for a given solution, so that if one become familiar with these pictures, one is able to diagnose to some extent the nature of the solution from the way in which the cell disintegrates.

This process of disintegration can be observed if the eggs are put into a pure solution of sodium chloride or in a mixture of sodium chloride and calcium chloride, or in a mixture of sodium chloride and potassium chloride. If, however, all three salts are used in the proportion in which they occur in the sea-water no disintegration takes place and the surface of the egg remains perfectly smooth and normal. One gains the impression as if the protoplasm of the egg were held together by a continuous surface film of a definite texture. If we put the egg into an abnormal solution this surface film is modified and changed, and the change of the surface film is often followed by a gradual process of disintegration of the rest of the cell.

These observations on the sea-urchin egg, therefore, suggest the possibility that the combination of the three salts in their definite proportion and concentration has the function of forming a surface film of a definite structure or texture, around the protoplasm of each cell, by which the protoplasm is kept together, protected against and separated from the surrounding media.

The previously mentioned observation of Herbst again shows the important rôle of calcium in this process.

IX

The objection might be raised that the beneficial action of the three salts could only be proved on marine animals or on tissues of higher animals, which are said to be "adapted" to a mixture of NaCl, KCl and $CaCl_2$ in definite proportions. Experiments on fresh-water organisms, for which "adaptation" to a mixture of NaCl, KCl and $CaCl_2$ in these definite proportions can not be claimed, show that this objection is not valid. Ostwald worked with fresh-water crustaceans which he put into mixtures of various salts. It was found that these animals live longer in a mixture of NaCl + KCl + $CaCl_2$ than in a solution of NaCl, or NaCl + KCl, or NaCl + $CaCl_2$ of the same osmotic pressure.

Osterhout was able to show that the spores of a certain variety of *Vaucheria* die in a pure 3/32 m. solution of NaCl in 10 to 20 minutes, while they live in 100 c.c. 3/32 m. NaCl + 1 c.c. 3/32 $CaCl_2$ 2 to 4 weeks, and in 100 c.c. 3/32 m. NaCl + 1 c.c. 3/32 m. $CaCl_2$ + 2.2 c.c. 3/32 m. KCl 6 to 8 weeks. The reaction of the solution was strictly neutral and the NaCl the purest obtainable. The results remained the same after the NaCl had been recrystallized six times. Experiments with *Spirogyra* gave a similar result. The solutions were all 3/32 m. In NaCl the *Spirogyra* died in 18 hours; in NaCl + KCl in two days; in NaCl + KCl + $CaCl_2$ they lived 65 days. Osterhout caused wheat grains to develop in such solutions and measured the total length of the roots formed.

Nature of the Solution	Total Length of Roots after 40 Days
H_2O	740 mm.
100 c.c. 3/25 NaCl	59 mm.
100 c.c. 3/25 NaCl+2.0 3/25 $CaCl_2$	254 mm.
100 c.c. 3/25 NaCl+2.0 3/25 $CaCl_2$ +2.2 3/25 m. KCl	324 mm.

These cases, to which many other similar observations might be added, prove that the life-preserving effect of the combination of $NaCl + KCl + CaCl_2$ in definite proportions is not due to the fact that organisms are "adapted" to this mixture but to a specific protective effect of the combination of the three salts upon the cells.

X

It seems, therefore, to be a general fact that wherever tissues or animals require a medium of a comparatively high osmotic pressure—like our tissues—their life lasts much longer in a mixture of $NaCl + KCl + CaCl_2$ in the proportion in which these salts exist in the blood and in the ocean, than in any other osmotic solution, even a pure solution of NaCl. But the reader has noticed that there are considerable differences in the resistance of various organisms to abnormal solutions. While marine *Gammarus* die in half an hour in an isotonic solution of NaCl or cane sugar, red blood corpuscles or even the muscle of a frog can be kept for a day or longer in such a solution (of course even the muscle of a frog lives longer if the NaCl solution contains in addition KCl or $CaCl_2$). What causes this difference?

Six years ago I found that the *unfertilized* eggs of the sea-urchin (*Strongylocentrotus purpuratus*) can keep alive and remain apparently intact in a pure neutral solution of $CaCl_2$ or of NaCl for several days at a temperature of 15°, while the *fertilized* eggs of the same female are killed in a pure neutral solution of $CaCl_2$ in a few hours. The same difference is found for other salts also. What causes this difference? Several authors, Lillie, McClendon and Lyon, have suggested that it is due to the fact that the fertilized egg is more permeable to salts than the unfertilized egg. But the recent experiments by Warburg, which were confirmed and amplified by Harvey make it doubtful whether the salts which are not soluble in fats can enter the fertilized egg at all. I believe that the explanation of the difference is much more simple. The unfertilized egg is surrounded by a cortical layer and this layer is destroyed or modified in the process of fertilization. One result of this modification is the formation of the fertilization membrane, for which I have been able to show that it is readily permeable for salts. As long as the cortical layer of the unfertilized egg is intact, it prevents the surrounding salt solution from coming in contact with the protoplasm or at least it retards this process. If, however, the cortical layer is destroyed by fertilization the surrounding salt solution comes directly in contact with the protoplasm and if the solution is abnormal it can cause the disintegration of the surface layer of the protoplasm.

I am inclined to believe that differences in the resisting power of various cells or organisms to abnormal salt solutions are primarily due to differences in the constitution of the protective envelopes of the animals or the cells. Microorganisms which can live in strong organic acids or salt solutions of a high concentration probably possess a surface layer which shuts off their protoplasm from contact with the solution. For the protoplasm of muscle the rather tough sarcolemma forms not an absolute but nevertheless an effective wall against the surrounding solution.

But aside from differences of this kind there are other conditions which influence the degree of resistance of cells to various solutions. I have found that the fertilized eggs of the sea-urchin will live longer in abnormal salt solutions if the oxidations in the egg are stopped, either by the withdrawal of oxygen or the addition of KCN or NaCN. Warburg and Meyerhof have drawn the conclusion that in a pure NaCl solution the rate of oxidations of the egg of *Strongylocentrotus* is increased and that it is this increase in the rate of oxidations which kills the eggs. But this increase of oxidations can not be observed in the eggs of *Arbacia* when they are put into a pure NaCl solution and, moreover, lack of oxygen prolongs the life of the fertilized egg just as well in solutions of $NaCl + CaCl_2$ or of $NaCl + BaCl_2$, for which salts these authors do not claim that they can raise the rate of oxidations of the egg. I am inclined to believe that in the process during or preceding cell division, besides phenomena of streaming inside the cell, changes in the surface film of the protoplasm occur, whereby this film is more easily injured by the salts. If we suppress the oxidations we suppress also the processes leading to cell division and thereby retard the deleterious action of the abnormal salt solution upon the surface layer of the protoplasm of the egg.

XI

If we now raise the question as to why salts are necessary for the preservation of the life of the cell we can point to a number of cases in which this answer seems clear. Each cell may be considered a chemical factory, in which the work can only go on in the proper way, if the diffusion of substances through the cell wall is restricted. This diffusion depends on the nature of the surface layer of the cell. Overton and others assume that this layer consists of a continuous membrane of fat or lipoids. This assumption is not compatible with two facts, namely that water diffuses very rapidly into the cell, and second, that life depends upon an exchange of water-soluble and not of fat-soluble substances between the cells and the surrounding liquid. The above mentioned facts of the antagonism between acids and salts suggest the idea that the surface film of cells consists exclusively or essentially of certain proteins.

The experiments mentioned in this paper indicate that the rôle of salts in the preservation of life consists in the "tanning" effect which they have upon the surface films of the cells, whereby these films acquire those physical qualities of durability and comparative impermeability, without which the cell cannot exist.

On this assumption we can understand that neutral salts should be necessary for the preservation of life although they do not furnish energy.

As far as the dynamical effects of salts are concerned it is not impossible that some of them belong also to the type of those mentioned in this paper. The fact that the addition of calcium to an NaCl solution prevents the twitchings of the muscle, which occur in the pure NaCl solution, suggests the possibility that the $CaCl_2$ merely prevents or retards the diffusion of NaCl through the sarcolemma. But other effects of salts, *e. g.*, the apparent dependence of contractility of the muscle upon the presence of NaCl; or the rôle of PO_4 in the nucleus, do not find their explanation in the facts discussed in this paper.

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POPULAR MISCONCEPTIONS CONCERNING PRECOCITY IN CHILDREN[1]

I

STUDENTS of the history of education know that at one time or another since Plato's day efforts have been made to hasten the development of children in respect to the acquisition of the formal branches of school instruction. Programs have been worked out with a view to teaching children to read and to write almost as soon as they should begin to talk. However, it is significant of our latter-day theories on this subject that the classical writers on education esteemed most highly in our times are distinguished because of their vigorous opposition to these forcing systems. Locke, Rousseau, Spencer, and their numerous disciples have devoted themselves to exposing the evil, as they have thought, of introducing children too early to reading, writing, arithmetic and the like, maintaining that children who were put to books too early were thereby made dull and stupid instead of intelligent and capable. These pioneers in the discussion of a rational educational régime endeavored to convince the parents and teachers of their day that the early years of life should be spent in spontaneous activities, in contact with nature, and in give-and-take relations with playmates. When Spencer took up the problem, he attempted to give scientific validity to the common-sense views of Locke and Rousseau by pointing out that it is easily possible to arrest the development of the child's brain by crowding him through subjects of study which are not suited to his stage of development. According to the Spencerian view, it is a mistake to stimulate brain areas before nature intended they should be exercised; which means, for one thing, that the child should not be taught the three R's at two or three or even four years of age. The followers of Spencer have been wont to interpret his views on this question by likening the development of the intellect to the development of the digestive and assimilative systems. If a babe be given meat before nature has prepared the organism for it, nothing but harm can result therefrom, which fact may be observed by any one who is not obsessed by notions to the contrary. Spencer brought forward biological and psychological evidence showing, as he believed, and as practically all students in this field now think, that there is a definite order in which the intellectual activities should be awakened; and if we try to upset this order in our educational programs we can hardly fail to disturb the delicate adjustments of the mind, and so to leave the individual all the weaker therefor in the end.

These views expressed by Locke, Rousseau, Spencer and many more recent students of education, biology, and psychology have profoundly influenced the thought and practise of teachers, and to a lesser extent of parents, in our own country. In some of the older countries the view is still popularly entertained that the child is a small-sized copy of the adult, possessing in miniature all the powers and faculties of a grown person. So that whatever is appropriate for the adult is also appropriate for the child, except that the doses must be reduced for the latter. It is the usual practise in certain of the schools of the Old World, and it was quite the fashion in our own schools a few decades ago, to introduce a child of four or five years of age to all the ordinary subjects of instruction in the elementary school. But the development of biological and psychological sci-

[1] Presented before Section L, American Association for the Advancement of Science, at the Minneapolis meeting.

ence in America, and its application to the problems of human life, have caused people to regard the child as different in most respects from the adult. And in his training he must receive what is adapted to his needs at different points in his evolution; which must be determined by observing him, rather than by giving him what may be suited for adults, only less of it, since he is not so large or strong. During the past few decades we have been hearing constantly that if the modes of thinking and the activities proper to an immature individual be suppressed in the child in order to rush him through the period of childhood, then the modes of thinking and the activities normal to adult life will be abortive or disordered, or they may not appear at all.

II

But within the last two or three years, teachers and parents have been thrown into a state of doubt and wonder on account of the reports which have been put in circulation to the effect that normal children two years of age or less have been taught to read readily, not only in the mother tongue, but in foreign languages; and at this tender age they have shown great facility in spelling, in numbers, and in all branches of elementary education. Recently an educational magazine published the following account of the abilities of Winifred Sackville Stoner, Jr., of Palo Alto, Cal., who was eight years of age at the time the report was made. The account says:

She can carry on a conversation in English, French, Spanish, Latin, Esperanto, Japanese, Russian, German, Polish and Italian, while in the first five she can think as well as talk. Miss Stoner is a healthy, normal child, as fond of dolls and play as any other little girl who knows only one language. Miss Stoner is also precocious as a writer of verse, and a volume of her compositions has been published. This young lady shows not only remarkably good sense of meter and rhyme, but a keen sense of humor not often allied with precocity. This brilliant young woman of eight years walked when she was six months old, talked when eight months old, and scanned Virgil at one year of age. She can take a sheet of music for the first time, and, after looking it through once, can tell every note that was on it and its place on the staff. These are only a few of the wonderful things that Winifred Sackville Stoner can do off-hand. The interesting part of it all is that she has no one unusual natural ability, but all this, from walking at six months, talking at eight months and scanning Virgil at twelve months, is acquired skill or art, as you please, the result of the prodigious activity of her teacher, Mrs. Stoner.

During the past three years accounts of extraordinary precocity, similar to that of Winifred Stoner, have been published regarding William James Sidis, of Brookline, and other children of various ages, but all under twelve. The news has been spread abroad very generally that these children mastered the mother tongue in its oral and written forms at two or three years of age; that in a single year, at five or six, they completed the eight grades of the elementary school, and that they pushed through the high school in a year or two. While they have been accomplishing these feats, they have had leisure to go far beyond the work of either the elementary or the high school in special subjects, as in mathematics in the case of Master W. J. Sidis, for instance. The accounts of the achievements of these children have all laid emphasis on the mastery, in infancy, of reading, writing, spelling, arithmetic, grammar and a little later of geometry, astronomy and the principles of physics, chemistry, mechanics, and even history, political economy and kindred branches. These reports have all emphasized the statement that the precocious children had not been robbed of their childhood, but that they spoke and conducted themselves

as children, even though they thought as adults, and even beyond most grown persons. One reads that a certain boy of eleven, on entering college, gave lectures in higher mathematics to the professors of the institution, some of whom had grown gray in the unsuccessful attempt to solve complicated problems which this child solved easily. At the same time he would romp like any ten-year-old; and on the street or on the playground he could not be distinguished from other typical boys of his age, concealing a highly developed brain behind childish features and actions. Magazine and newspaper writers have ascribed this marvelous intellectual development wholly to a rational educational system, wherein children were taught to concentrate their attention, and never to waste their time or energy.

During the last eighteen months, the writer of this paper has listened to nine different addresses by educators in various parts of the country, all of which assumed that the accounts of the precocity of Sidis and other children were founded on fact, and that somewhat similar results could and ought to be attained in the regular work of the school. The writer has read hundreds of newspaper editorials and comments on these childish prodigies; and the gist of most of them is that our prevailing methods of teaching in the public schools are, on the whole, of more harm than good, for they waste much of the period of childhood, and develop bad mental habits in the young. Naturally these criticisms have raised in many teachers' minds the queries whether our present conception of childhood is not altogether erroneous, and whether our educational system is not entirely wrong. Already in some localities the suggestion is being made that children should enter school two or three years earlier than they commonly now do, and that they should devote themselves at the outset wholly to reading, writing, spelling, grammar and arithmetic; that work with the hands, stories of all sorts, nature study, drawing, music and the like should be eliminated from the curriculum. Statements have been made to the effect that any typical boy can be got ready for college at ten or eleven by starting him in to read at two. The chief trouble in our schools of to-day, say the newspaper writers and some educational lecturers, is that children do not learn to think correctly or effectively, because they are not trained from the beginning in the subjects which are of chief value in developing right modes of thought.

III

The present writer has attempted to get from those close to some of the precocious children referred to precise and detailed accounts of just what they had accomplished in the various branches in which they have been reported to be proficient, but nothing but general and unsatisfactory statements have been secured. So far as can be ascertained, there are accessible no really reliable data of a sufficiently detailed and specific character to enable one to determine exactly what kind of ability Miss Stoner, Jr., or Master Sidis, or any of their class possesses in reading or arithmetic or calculus or Hebrew or what not. So we must take the popular accounts, such as parents, teachers and editors are attaching importance to, and see what lessons may be drawn from them. Take reading, for instance; some of these children "can read very readily at the age of two." Now, one may learn to recognize words so that he can pronounce them, but still not be able to *read* in a true sense—that is to say, his knowledge of a word may not be anything but merely verbal. It may sug-

gest to him but a very slight part and possibly not any, of the subtle meaning which it has come to possess through a long process of development. The writer, to try out this principle, has conducted some experiments upon school children, with a view to discovering whether individuals could correctly pronounce words they did not understand in any adequate or precise manner. The method of teaching reading in the schools in which the experiments were made leads pupils to endeavor to attach some meaning to all new words in their lessons; but even so, there was not a pupil tested beyond the third grade who could not readily pronounce words which were utterly unintelligible to him, these words being chosen from the works of Shakespeare, Spencer, Emerson and Roosevelt. Practically all these pupils could easily pronounce the words in complete passages which meant nothing to them. Again, I tried these pupils in reading problems in arithmetic and theorems in geometry; and most of them could without hesitation pronounce the words in problems they could not interpret. Other tests, some of them with university students reading a foreign language, simply impressed the principle that the oral rendering of words and sentences is one thing, while the correct appreciation of them in all their significations is an altogether different thing.

It will be readily granted that the least important part of the process in reading is simple recognition of words as mere verbal forms, either visual or auditory. Most of what is vital in learning to read, and which is a test of the degree of mental development one has reached, has reference to the gaining of the meaning which words and phrases have gradually come to denote. He who can not bring these meanings before consciousness when he looks upon words, even though he can pronounce them, has not learned to read in a true sense, as this term should be understood. He has simply gained a certain degree of familiarity with a peculiar kind of visual object—an extremely simple, mechanical sort of thing, requiring no very high degree of mentality to master.

Perhaps a special phase of the general matter before us should be impressed at this point. A child, or even an adult, may be able to recognize isolated words, so that he can pronounce them, and an onlooker may say that he can read them. But reading for the gaining of content does not consist so much in dealing with isolated words, as in grasping, as a whole, the phrase, the clause or the sentence. Any good reader is largely unconscious of particular words in his reading. These fuse into larger unities, which alone convey real meaning. But a child may be taught to recognize and vocalize detached words, while at the same time he may be utterly unable to combine these into patterns in the way in which they must be actually utilized in gaining or expressing thought. One often comes across children who can call off the individual words in a sentence, but they may be utterly at sea when asked to give the meaning of this sentence. They fail to grasp it as a unity, and so it has little, if any, meaning for them.

It is a simple matter of psychology that reading for content, instead of simply for verbal recognition, can not go beyond the individual's experience with the meaning which is denoted. No one would be quite so foolish as to claim that a child of two who had had no experience outside of his nursery could read understandingly the Old Testament, for instance, or Tennyson's "In Memoriam," or Milton's "Paradise Lost." It is possible he might be taught to pronounce the words; but reading for

him would be a process simply of verbal recognition and vocal execution, and the really essential element in the reading would be entirely beyond him.

But when reports are circulated of the extraordinary reading ability of two- or three-year-old children, adults are likely to interpret the statements made from the standpoint of their own processes in reading, wherein they are concerned almost wholly with content instead of form, and they are amazed, because they can not conceive how a child of so tender an age could amass such a fund of experience as reading Plato and Shakespeare and Darwin requires. The majority of people, in their off-hand way, consider reading as a unitary process, and they jump to the conclusion that pronouncing words denotes appreciation of meaning; and herein is the foundation for one popular misconception regarding precocity as described in the public prints.

IV

Reports of the remarkable mathematical ability of four-year-old American children have been extensively circulated throughout our country and abroad. It has been said that these prodigies have worked through algebra, geometry, calculus and other branches of higher mathematics at this early age. But as in the case of reading, so here it is necessary to determine just what kind of mathematical ability is displayed by these children. The writer has tested a group of pupils in the second grade who are able to perform the fundamental operations in arithmetic, but who have no true arithmetical images or concepts. It is a simple matter of psychology that the figures *4*, *5* and *9* may be so frequently seen together in a certain special relation that when the first two are perceived the last will inevitably arise. This is nothing but a mere mechanical association of impressions—the lowest form of intellectual organization.

Again, any one who will take the trouble to look for them may find children who are able to apply the fundamental operations in a variety of ways following certain models that have been shown them, but they do not comprehend the actual situations which are symbolized by these processes. They simply manipulate figures according to a given pattern; they do not construct mentally any vital content for their symbolic operations. This latter thing is what the mature individual is constantly doing, if he has developed properly, and he is apt to assume that the child too conceives actual situations in the world of things when he solves his problems; and this is another reason for popular error in reacting upon tales of precocious children.

We might illustrate this latter point by referring to some common game, as checkers. No one will say that if a child should learn how to jump men on a checker board, imitating examples of the method given him by others, that on this account he would display any knowledge of the world of people or things about him. He would simply be required to establish a series of mechanical associations which may never be utilized anywhere in the world except on the checker board. To say that because a two-year-old child could play checkers he was therefore highly developed intellectually would be rather absurd. There are on record cases of persons wholly incompetent, even feeble minded in most things, who could carry through a game like checkers very well; and even simpler and easier is the process of arithmetical computation, which has in certain cases been developed to a marvelous extent by persons who have been imbeciles in most other respects. For a two-year-old child

to be able to play checkers would indicate simply that he had developed the power of attending to this sort of thing beyond what most normal children of this age spontaneously manifest; though if it were thought to be worth while the typical child could easily be trained to do this thing with a greater or less degree of success.

But while a two-year-old might be able to attend to the sort of situation presented on a checker board, he might at the same time be utterly deficient in attending to an unfamiliar human face so that he could recognize it the next time he saw it, and especially so that he might know whether to laugh or to cry in the presence of the stranger. It can scarcely be doubted that it requires a much higher order of intellectual process to discern the traits of a stranger in order to discover what to do with regard to him, than to learn to move checkers on a board, or to tell that six and six make twelve, or to solve a problem in cube root or quadratic equations, or to speak seven different languages, and so on. The analysis of a human personality, and the interpretation of what is observed, is a more complicated matter than the analysis of any situation presented in mathematics. More factors have to be taken account of in deciding what sort of attitude to assume toward a person than to solve any problem in calculus. And moreover, these factors are very subtly related to one another; they are plastic and dynamic, and extremely variable as compared with mathematical phenomena. One can take his time about a problem in Euclidean geometry. The relations to be discovered will not change from one moment to another; they are static and permanent. They are not affected by environing conditions, which characteristic makes them far more simple psychologically than any living thing, and especially than a human being, whose expressions, which the child must apprehend and interpret, vary with a varying environment, so that they are likely to be constantly passing from one variety into another. But even so, every normal child of two years of age is constantly analyzing living, and particularly human beings, and drawing more or less correct inferences from the phenomena observed. A typical two-year-old child knows what sort of an attitude to take toward his father and mother and brothers and sisters and servants in many of their different moods. If he has come in contact with people outside the family, he may be able to adjust himself fairly well to a considerable number of people who may differ from one another in various respects. The child of this age who has pets knows how to deal with them appropriately to their main distinguishing traits; and he will modify his attitude toward them according as their expressions change. When it comes to inanimate objects, the young child understands the essential nature of a large number of them, so that he can adapt himself to them.

From the standpoint of precocity, all this vital knowledge of living and inanimate things, which the typical two-year-old possesses, is far more wonderful than a knowledge of the forms of words, or operations with numbers, or even applying geometrical formulæ to particular problems. It seems reasonable to say that every normal five-year-old child has performed much more difficult feats in discovering the qualities of human beings say, and adjusting himself to them, than would be essential in learning to speak sentences in Spanish, French, German and Greek. This statement will doubtless be questioned by one who has not reflected upon the matter; but the reason it may seem extreme is because it is more in line with

custom and with native tendency for a young child to learn how to adapt himself to the world of people and things about him than to memorize verbal combinations. It is to be expected that people will marvel at the accomplishments of a boy of ten who can speak divers tongues, and recite geometrical demonstrations, because such feats are unusual, not because they are at all impossible for the typical child, or because they denote a superior order of mental development. What such precocious performances indicate is simply that the mind of the "prodigy" has been stimulated in these particular directions, often, if not always, to the exclusion to a greater or less extent of stimulation in the ordinary directions.

The writer has subjected certain so-called precocious children in language and the like to tests which were designed to show whether they had learned as much about nature and human nature, and had acquired as much skill in manipulating inanimate objects about them at the age of nine or ten, as the typical child whose time and energies from birth onward had been devoted largely to learning *things* as contrasted with *words* and *formulæ*. Making allowances for rare exceptions, it may be said that pupils who are precocious in speaking and reading foreign tongues, and working text-book problems in arithmetic, algebra and geometry, are distinctly inferior to the typical children of their age in their understanding of realities, and especially in effective reaction upon the environment in making it over into new forms or patterns, or directing the forces of nature into new channels. These precocious children often memorize the contents of an arithmetic say, without having any adequate notion of the realities which arithmetical processes ought to symbolize. They may learn the table of dry measure, for instance, so they can recite it off, and apply it in text-book problems, but without having any just conception of the size and relation of the units which are mentioned in the table, or any notion of how they are utilized in every-day life in facilitating the relations between human beings.

And what is true of precocity in arithmetic is true in principle of all the studies pursued in the schools, especially of such subjects as algebra, geometry, and other branches of mathematics, which are so frequently mentioned in all discussions of precocity. Marked ability in the formal aspects of these subjects, such aspects as are emphasized in the schools usually, may go along with utter incapacity in adjustment to the vital situations of life. Consider which requires the higher degree of mental development—to look on a group of algebraic symbols at leisure, change their positions according to a pattern-method which has been presented; or to discern the characteristics of a new companion who may come into a group, and to determine with celerity what he can be used for, and how he must be dealt with. The fact that the former situation is less interesting to the child than the latter should not prevent one from seeing its relative simplicity. Inasmuch as algebra, geometry, German and so on lack color, life and vitality for the young child they do not appeal to him as do the human face and many natural objects, which are so intimately bound up with his welfare. The mind of the child is unquestionably constructed on a plan whereby attention must be given primarily to people and to things as contrasted with words and symbols, because the former have played the leading rôle in human evolution. If our forbears had not shown a spontaneous interest in the realities in their environment

the race would have been eliminated long ago.

This fact may warrant the statement at this point that the study of people and of natural objects and forces should furnish the principal material for the young child's education. He must get his mental set in the direction of gaining insight, first into the qualities and needs of his fellows, and second into the constitution of nature, and the operation of her laws. Not books but realities should constitute the earliest nourishment of the mind. To give the child a set in the beginning so that he would be more interested in the symbols for realities than in the realities themselves would result in arresting his mental development, and in developing in him a type of mind capable only of working on the lower planes of mechanical association. And it is easily possible to commit this latter sort of crime. One who will look about him in the schools will not lack for evidence showing that children who have early been nurtured upon symbols have never gained a true feeling for or interest in the real world in which they must live and have their being.

One of the most interesting phases of present-day discussion of precocity is the high value which the average person puts upon the ability of a child to enter college at an unusually early age. When a boy passes college entrance examinations at the age of eleven or twelve, everyone who hears of it is likely to exclaim at his remarkable intellectual development. But one might justly say of the requirements for entering college that they are mainly verbal, conventional, and symbolic; they concern the *tools* of knowledge, not true knowledge itself. A pupil might be able to pass brilliantly in every examination for admission to many colleges, without possessing the ability to adjust himself to life efficiently. A boy might have to sit in a corner when he was among a group of his own fellows, but yet he might work out quadratic equations with success. A child might be quite incapable of using his muscles in the performance of any useful motor task, and still he might be able to demonstrate that the sum of the interior angles of a triangle equals two right angles. The college entrance examinations, speaking generally (it is not so true to-day as it was formerly) test only a low order of knowledge, mostly the variety requiring for its mastery mainly mechanical memory. The colleges themselves now appreciate this, and the problem of changing the examination system so that it may measure real ability instead of mere verbal learning is receiving attention throughout the country.

Finally, it may be said that in all times students of mental development and of education have recognized that if knowledge be presented to the child in accordance with the laws of apperception, he will progress far more rapidly in comprehending the world around him than if he be left wholly to himself, or if ignorant teachers present facts to him so that he can not grasp them and assimilate them. One who has skill and patience in leading a child always to understand what he sees about him, and to discern the laws which govern things, can in time give him a set so that he will spontaneously come to search after the real connections between the objects and phenomena he observes. It seems evident that this has been done to some extent in the case of certain children whose intellectual attainments have attracted attention during the past two or three years; and they may perhaps be said to be really precocious. However, there can be no doubt that many children have attained just as great advancement in informal education; but knowledge of

this latter kind does not attract the attention of the multitude, partly because it can not be readily tested in examination, and secondly because it is more ordinary, more common. It is the unusual thing always that arouses the wonder of people, and sets them to talking.

V

These modern instances of intellectual prodigies, then, give us no new view of human nature, and no new theory of education. They simply indicate what may be achieved in any particular direction by persistent, systematic, organized instruction. The particular intellectual achievements of these cases serves as no indication of how the majority of children ought to be trained; but they do impress the value of educational principles which are familiar to all who are in the business.

M. V. O'Shea
The University of Wisconsin

THE WASHINGTON MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The sixty-third meeting of the American Association for the Advancement of Science, and the tenth of the "convocation week" meetings, will be held in Washington, December 27 to 30, 1911. A meeting of the executive committee of the council (consisting of the general secretary, the secretary of the council, the permanent secretary, and the secretaries of all of the sections) will be held at the office of the permanent secretary, in the New Willard Hotel, at noon, on Tuesday, December 26. The opening general session of the association will be held at 8 o'clock P.M., on Wednesday, December 27, in the main assembly hall, new U. S. National Museum. The council will meet Wednesday morning, December 27, in the New Willard Hotel at 9 o'clock. Sections will meet in their respective halls at 10 A.M. on Wednesday.

The program for the *entire meeting* will be issued on Wednesday, December 27, and copies may be obtained at the office of the permanent secretary in the New Willard Hotel.

The following events may be announced in advance:

Tuesday, December 26

The register for the Washington meeting will be open from 9:00 A.M. to 4:30 P.M., at the general office of the association in the Smithsonian Institution, and on following days from 9:00 A.M. to 5:00 P.M. at hotel headquarters, New Willard Hotel. The register will be open from 6:30 to 9:00 P.M. at hotel headquarters, New Willard Hotel.

Wednesday, December 27

9:00 A.M.—The council will meet in the council room at the New Willard Hotel. Registration from 9:00 A.M. to 5:00 P.M.

10:00 A.M.—The sections will meet in their respective meeting-places for organization, and where sections have programs the reading of papers will begin after organization.

2:00 P.M.—Meetings of the sections and affiliated societies.

2:30 P.M.—Addresses by retiring vice-presidents as follows: Vice-president Frankforter, before the Section of Chemistry, on "The Resins and their Chemical Relations to the Terpenes"; Vice-president Reighard, before the Section of Zoology, on "Adaptation"; Vice-president Harper, before the Section of Botany, on "Some Current Conceptions of the Germ Plasm."

8:00 P.M.—First general session of the association in the assembly hall of the new U. S. National Museum. The meeting will be called to order by the retiring president, Dr. A. A. Michelson, who will introduce the president of the meeting, Dr. Charles E. Bessey. It is expected that the address of welcome will be given by the president of the United States. Reply by President Bessey. Announcements by secretaries. Agreement on the hours of meetings. Annual address by the retiring president, Dr. A. A. Michelson, on "Recent Progress in Spectroscopic Methods." Adjournment of the general session, to be followed by an informal reception and inspection of the exhibits of the new National Museum.

Thursday, December 28

9:00 A.M.—The council will meet in the council room at the New Willard Hotel. Registration from 9:00 A.M. to 5:00 P.M.

10:00 A.M.—Programs of sections and affiliated societies.

2:30 P.M.—Addresses by retiring vice-presidents as follows: Vice-president Rosa, before the Section of Physics, on "Work of the Electrical Division of the Bureau of Standards"; Vice-president Rotch, before the Section of Mechanical Science and Engineering, on "Aerial Engineering"; Vice-president Hill, before the Section of Education, on "The Teaching of General Courses in Science."

3:00 to 4:30 P.M.—Exhibition cavalry drill at Fort Myer, Va.

8:00 P.M.—Informal reception at the Corcoran Art Gallery, by invitation of the trustees of the gallery.

FRIDAY, DECEMBER 29

9:00 A.M.—The council will meet in the council room at the New Willard Hotel. Registration from 9:00 A.M. to 5:00 P.M.

10:00 A.M.—Continuation of programs of sections and affiliated societies.

2:30 P.M.—Addresses by retiring vice-presidents as follows: Vice-president Moore, before the Section of Mathematics and Astronomy, "On the Foundations of the Theory of Linear Integral Equations"; Vice-president Dixon, before the Section of Anthropology and Psychology, on "The Independence of the Culture of the American Indian," Vice-president Novy, before the Section of Physiology and Experimental Medicine, title to be announced.

3:00 P.M.—Vice-president Burton, before the Section of Social and Economic Science, on "The Cause of High Prices."

SATURDAY, DECEMBER 30

10:00 A.M.—Continuation of programs of sections and affiliated societies.

There will be a number of joint meetings and the usual smokers and dinners and meetings of special societies and groups.

The plan of meeting places is as follows:

Section A—Mathematics and Astronomy—Carnegie Institution, corner Sixteenth and P Streets.

Section B—Physics, with American Physical Society—Bureau of Standards, Connecticut Avenue extended.

Section C—Chemistry, with American Chemical Society—McKinley Manual Training School, Seventh Street and Rhode Island Avenue.

Section D—Mechanical Science and Engineering—Georgetown Law School, 506 E Street N. W.

Section E—Geology and Geography, with Geological Society of America—New National Museum, Eleventh and B Streets.

Section F—Zoology—New National Museum.

Section G—Botany, with Botanical Society of America—Business High School, Ninth Street and Rhode Island Avenue.

Section H—Anthropology and Psychology, with American Anthropological Association—Public Library, Seventh and K Streets.

Section I—Social and Economic Science, with American Economic Association—New Raleigh Hotel, Twelfth Street and Pennsylvania Avenue.

Section K—Physiology and Experimental Medicine—To be announced in daily program.

Section L—Education—To be announced in daily program.

A railroad rate of one fare and three fifths for the round trip, on the certificate plan, has been granted by the Trunk Line Association, the Eastern Canadian and the New England Passenger Associations (not including the Bangor and Aroostook Railroad and the Eastern and the Metropolitan Steamship Companies). The Southwestern Passenger Association offers no special rate, but advises members to take advantage of the "Christmas Holiday Excursion Rates," the dates of sale being December 15, 16, 17 and 21 to 25, inclusive, with final return date of January 8, 1912. From the states of California, Nevada, Oregon, Washington and west of, and including, Mission Junction, B. C.; also from what are known as Kootenay common points, namely, Nelson, Rossland, Sandon, Kaslo and Grand Forks, B. C., the Transcontinental Passenger Association has on sale daily Nine Months Tourists fares, approximating two cents per mile in each direction, or about one fare and one third for the round trip. The nine months fares apply to the eastern gateways of the transcontinental territory, and station agents will cheerfully advise delegates as to the eastern points to which it will be most advantageous for them to purchase nine months tickets in rebuying through to Washington.

The officers for the Washington meeting are:

President—Charles E. Bessey, University of Nebraska, Lincoln, Nebr.

Vice-presidents—

A—Mathematics and Astronomy, Edwin B. Frost, Yerkes Observatory, Williams Bay, Wis.

B—Physics—Robert A. Millikan, University of Chicago, Chicago, Ill.

C—Chemistry—Frank K. Cameron, U. S. Department of Agriculture, Washington, D. C.

D—Mechanical Science and Engineering—Charles S. Howe, Case School of Applied Science, Cleveland, Ohio.

E—Geology and Geography—Bohumil Shimek, State University of Iowa, Iowa City, Iowa.

F—Zoology—Henry F. Nachtrieb, University of Minnesota, Minneapolis, Minn.

G—Botany—Frederick C. Newcombe, University of Michigan, Ann Arbor, Mich.

H—Anthropology and Psychology—George T. Ladd, Yale University, New Haven, Conn.

I—Social and Economic Science—J. Pease Norton, Yale University, New Haven, Conn.

K—Physiology and Experimental Medicine—William T. Porter, Harvard Medical School, Boston, Mass.

L—Education—Edward L. Thorndike, Columbia University, New York, N. Y.

Permanent Secretary—L. O. Howard, Smithsonian Institution, Washington, D. C.

General Secretary—John Zeleny, University of Minnesota, Minneapolis, Minn.

Secretary of the Council—Theodore S. Palmer, U. S. Department of Agriculture, Washington, D. C.

Secretaries of the Sections—

A—Mathematics and Astronomy—George A. Miller, University of Illinois, Urbana, Ill.

B—Physics—A. D. Cole, Ohio State University, Columbus, Ohio.

C—Chemistry—C. H. Herty, University of North Carolina, Chapel Hill, N. C.

D—Mechanical Science and Engineering—G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

E—Geology and Geography—F. P. Gulliver, Norwich, Conn.

F—Zoology—Maurice A. Bigelow, Columbia University, New York, N. Y.

G—Botany—Henry C. Cowles, University of Chicago, Chicago, Ill.

H—Anthropology and Psychology—George Grant MacCurdy, Yale University, New Haven, Conn.

I—Social and Economic Science—Seymour C. Loomis, 69 Church Street, New Haven, Conn.

K—Physiology and Experimental Medicine—George T. Kemp, 8 West 25th Street, Baltimore, Md.

L—Education—C. Riborg Mann, University of Chicago, Chicago, Ill.

Treasurer—R. S. Woodward, Carnegie Institution, Washington, D. C.

Assistant to Permanent Secretary—F. S. Hazard, Office of the A. A. A. S., Smithsonian Institution, Washington, D. C.

The following societies have indicated their intention to meet in Washington during convocation week in affiliation with the American Association for the Advancement of Science:

American Anthropological Association.—Meets on Wednesday, Thursday, Friday and Saturday, December 27 to 30, in the Public Library. One afternoon to be devoted to discussion of topic, ''Environment and Culture.'' Joint meeting with American Folk-Lore Society on Thursday, December 28. Secretary, Dr. George Grant MacCurdy, Yale University Museum, New Haven, Conn.

Astronomical and Astrophysical Society of America.—Meets on Wednesday, Thursday and Friday, December 27 to 29, in Carnegie Institution. Secretary, Professor William J. Hussey, Ann Arbor, Mich.

Society of American Bacteriologists.—Meets on Wednesday, Thursday and Friday, December 27 to 29, in the Cosmos Club. Joint meetings with Section K and American Phytopathological Society. Secretary, Dr. Charles E. Marshall, East Lansing, Mich.

American Society of Biological Chemists.—Meets in Baltimore, Md., from Wednesday morning, December 27, to Friday noon, December 29. Joint session to be held in McKinley Manual Training School, Washington, D. C., with the Biological Section, American Chemical Society, on Friday afternoon, December 29. Secretary, Professor A. N. Richard, University of Pennsylvania, Philadelphia, Pa.

Botanical Society of America.—Meets on Wednesday, Thursday and Friday, December 27 to 29, in the Business High School. Joint session with Section G and American Phytopathological Society on Friday, December 29. Secretary, Dr. George T. Moore, Missouri Botanical Garden, St. Louis, Mo.

American Chemical Society.—Meets on Wednesday, Thursday, Friday and Saturday, December 27 to 30, in the McKinley Manual Training School. Biological Section meets in joint session with American Society of Biological Chemists on Fri-

day afternoon, December 29. Secretary, Professor Charles L. Parsons, New Hampshire College, Durham, N. H.

American Civic Alliance.—Meets on Friday, December 29, in the New Raleigh Hotel. Secretary, Gerald Van Casteel, 165 Broadway, New York, N. Y.

American Economic Association.—Meets on Wednesday, Thursday, Friday and Saturday, December 27 to 30, in the New Raleigh Hotel. Secretary, Professor T. N. Carver, Harvard University, Cambridge, Mass.

American Association of Economic Entomologists.—Meets on Wednesday, Thursday and Friday, December 27 to 29, in the new National Museum. Joint session with the Entomological Society of America on Wednesday, December 27, at 1 P.M. Secretary, A. F. Burgess, Melrose Highlands, Mass.

Entomological Society of America.—Meets on Tuesday and Wednesday, December 26 and 27, in the new National Museum. Secretary, Dr. Alex. D. MacGillivray, 604 East John St., Champaign, Ill.

American Fern Society.—Meets in the Business High School. Dates of meetings not yet announced. Secretary, Professor L. S. Hopkins, Lincoln High School, Pittsburgh, Pa.

American Folk-Lore Society.—Meets on Thursday, December 28, in the Public Library. Joint meeting with American Anthropological Association. Secretary, Dr. Charles Peabody, Peabody Museum, Cambridge, Mass.

Association of American Geographers.—Meets on Thursday, Friday and Saturday, December 28 to 30, in Hubbard Memorial Hall. Secretary, Professor Albert P. Brigham, Colgate University, Hamilton, N. Y.

Geological Society of America.—Meets on Wednesday, Thursday, Friday and Saturday, December 27 to 30, in the new National Museum. Secretary, Dr. E. O. Hovey, American Museum of Natural History, New York, N. Y.

American Federation of Teachers of the Mathematical and the Natural Sciences.—Meets on Wednesday, Thursday and Friday, December 27 to 29, in Georgetown Law School Building, 506 E Street, N. W. Joint sessions will be held with Section L. Secretary, Professor Eugene R. Smith, Polytechnic Institute, Brooklyn, N. Y.

American Home Economics Association.—Meets on Thursday, Friday and Saturday, December 28 to 30. Place of meeting to be announced. Secretary, Dr. Benjamin R. Andrews, Teachers College, Columbia University, New York, N. Y.

Society for Horticultural Science.—Meets on Friday, December 29, at the Business High School. Secretary, C. P. Close, College Park, Md.

American Association for Labor Legislation.—Will meet in the New Raleigh Hotel. Dates to be announced. Secretary, Dr. John B. Andrews, Metropolitan Tower, New York, N. Y.

American Microscopical Society.—Will hold business session only, on date to be announced. Place of meeting: New Ebbitt House. Secretary, Dr. T. W. Galloway, James Millikin University, Decatur, Ill.

American Nature-Study Society.—Meets on Wednesday and Thursday, December 27 and 28, in the Business High School. President and Acting Secretary, Dr. Benjamin M. Davis, Miami University, Oxford, Ohio.

Paleontological Society of America.—Meets on Thursday, Friday and Saturday, December 28 to 30, in the new National Museum. Secretary, R. S. Bassler, U. S. National Museum, Washington, D. C.

American Physical Society.—Meets with Section B at the U. S. Bureau of Standards. Dates to be announced. Secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

American Physiological Society.—Meets on Friday, December 29, in the George Washington Medical School. Joint session with Section K. Secretary, Dr. A. J. Carlson, University of Chicago, Chicago, Ill.

American Phytopathological Society.—Meets at the Business High School on dates to be announced. Joint sessions with Section G and Botanical Society of America on Wednesday and Thursday, December 27 and 28. Secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

American Psychological Association.—Meets on Wednesday, Thursday and Friday, December 27 to 29, in the George Washington Medical School. Joint meeting with Sections F and L on dates to be announced. Secretary, Professor W. V. Bingham, Dartmouth College, Hanover, N. H.

Sigma Xi.—Annual meeting in affiliation with A. A. A. S. to be held on Friday afternoon, December 29. Place to be announced.

American Sociological Association.—Will meet in the New Raleigh Hotel on dates to be announced. Secretary, Professor A. A. Tenney, Columbia University, New York, N. Y.

American Statistical Association.—Will meet in the New Raleigh Hotel on dates to be announced. Joint meeting with American Economic Association on Thursday, December 28, at 8 P.M. Secre-

tary, Professor C. W. Doten, Massachusetts Institute of Technology, Boston, Mass.

Sullivant Moss Society.—Meets on Thursday, December 28, in the Business High School. Secretary, Mrs. Annie Morrill Smith, 78 Orange Street, Brooklyn, N. Y. Acting Secretary, W. R. Maxon, U. S. National Museum, Washington, D. C.

Southern Society for Philosophy and Psychology.—Meets on Friday and Saturday, December 29 and 30, in the George Washington Medical School. Joint meeting with American Psychological Association on date to be announced. Secretary, Dr. R. M. Ogden, University of Tennessee, Knoxville, Tenn.

SCIENTIFIC NOTES AND NEWS

It is cabled from Stockholm that the Nobel prize for chemistry has been awarded to Mme. Curie, of the University of Paris. These preliminary announcements are usually but not always correct. The Nobel prize in 1903 was awarded half to Professor Pierre Curie and Mme. Curie and half to Professor Becquerel.

The daily papers state that Dr. J. M. T. Finney, A.B. (Princeton '84), M.D. (Harvard '89), of the surgical staff of Johns Hopkins Hospital, has been offered the presidency of Princeton University.

Dr. Elmer E. Brown, late U. S. commissioner of education, was installed as chancellor of New York University on November 9.

Professor Ernest W. Brown, of Yale University, has been elected an honorary fellow of Christ's College, Cambridge.

At the annual meeting of the Royal Society of Edinburgh on October 23, Sir William Turner, K.C.B., F.R.S., was elected president, and Professor J. C. Ewart, F.R.S., Dr. J. Horne, F.R.S., Dr. J. Burgess, Professor T. Hudson Beare, Professor F. O. Bower, F.R.S. and Sir Thomas R. Fraser, F.R.S., were elected vice-presidents.

The following astronomers have been elected honorary members of the Astronomical Society of Mexico: Professor A. Abetti, Florence; Professor G. Fayet, Nice; Professor R. H. Baker, University of Missouri; Professor F. W. Dyson, Astronomer Royal of England; Professor S. A. Mitchell, of Columbia University, and Professor W. Ebell, Kiel.

Dr. George Blumer, dean of the faculty of Yale Medical School, was elected president of the Connecticut Society for Mental Hygiene, at the third annual meeting of the society, held recently in New Haven.

The fellowship of the International School of American Archeology and Ethnology at Mexico City, has been awarded by Harvard University to George Plummer Howe, A.B. 1900, M.D. 1910, of Lawrence, Mass.

Dr. Willis W. Waite has resigned as city bacteriologist of Syracuse, N. Y., to become director of Dr. Hugh Crause's Clinical Laboratory, of El Paso, Texas.

Professor R. T. Crawford, of the Berkeley astronomical department, University of California, is absent on leave during the academic year and is at present in Germany. During his absence Professor D. W. Morehouse, of Drake University, has been appointed instructor in astronomy.

Dr. Osten Bergstrand has been appointed professor of astronomy and director of the Observatory at Upsala.

Professor W. J. Hussey, who left Ann Arbor in June to assume the directorship of the Observatory of the National University of La Plata, Argentina, is engaged in the reorganization of the scientific work of that institution and is prosecuting his own researches in the field of visual double stars with gratifying results. Professor Hussey retains his connection with the Observatory of the University of Michigan and is developing the plan of cooperation in astronomical work between the universities of Michigan and La Plata, announced in Science earlier in the year.

Dr. W. A. Cannon, of the Desert Laboratory, has returned to this country after traveling sixteen months in Europe and north Africa. He visited deserts adjacent to the Nile River in Upper Egypt, and the southern part of Algeria. In the latter country he explored the region little known to botanists between Ghardaia and Ouargla, and visited Tougourt and the Oued Rirh.

William Travis Howard, M.D., professor of pathology, pathological anatomy and bacteriology, and Hippolyte Gruener, Ph.D., professor of chemistry in Western Reserve University, have returned from a year's leave of absence spent in Europe. For the year 1911–12, leave of absence has been granted to Olin Freeman Tower, Ph.D., Hurlbut professor of chemistry, who will spend the year abroad.

Dr. Thomas E. Jones, of the new University of Queensland, Australia, is at present in this country on a tour of inspection around the world to study the system of correspondence study at different universities.

During the meeting of the American Mining Congress, Chicago, October 24–28, twenty-eight geologists were in attendance. These included five representing the U. S. Geological Survey, fifteen from various State Surveys and eight from the Universities of Chicago, Northwestern, Wisconsin and Illinois. One evening was made enjoyable by a birthday dinner tendered to Dr. Eugene A. Smith, state geologist of Alabama. Dr. Smith is still vigorous at the age of 70. He has been in his present official position since 1871 and has published thirty-five or more volumes pertaining to the geology of Alabama or related subjects. His name will go down with that of LeConte and Hilgard as pioneers in science in the south. On the recent occasion toasts were offered by Dr. George Otis Smith on behalf of the U. S. Geological Survey; by Professor A. H. Purdue on behalf of the state geologists, and by Professor T. C. Chamberlin on behalf of the university group.

The council of the Institution of Civil Engineers has made the following awards in respect of papers published in the *Proceedings* for the session 1910–11: Telford premiums to S. M. Dixon, M.A. (Birmingham), H. J. F. Gourley, B.Eng. (London), J. Holden (London), A, Rogers (Horsell), A. E. Griffin (Hong-Kong), and F. C. Lea, D.Sc. (Birmingham); and a Crampton Prize to Professor W. E. Dalby, M.A., B.Sc. (London). The Indian premium for 1911 has been awarded to C. E. Capito (Ahwaz, Persia), and the Webb prize to F. W. Bach (London).

It is stated in *Nature* that at the conclusion of the Harveian Oration, delivered by Dr. Theodore Williams at the Royal College of Physicians, on October 18, the president of the college, Sir Thomas Barlow, presented the Baly and the Bisset Hawkins gold medals. The Baly medal was awarded to Professor W. D. Halliburton, F.R.S. This medal was instituted in 1866 "in memoriam Gulielmi Baly, M.D.," and is awarded every alternate year to the person who is deemed to have most distinguished himself in the science of physiology, especially during the two years immediately preceding the award, and is not restricted to British subjects. The Bisset Hawkins medal was given to Dr. Clement Dukes. This medal was established in 1896 by Captain E. Wilmont Williams, at the suggestion of Dr. Theodore Williams, to perpetuate the memory of Dr. Bisset Hawkins. It is bestowed triennially on some duly qualified medical practitioner who is a British subject, and has during the preceding ten years done work deserving special recognition in advancing sanitary science or in promoting public health.

As Bross lecturer for this year, Professor Josiah Royce, Ph.D., of Harvard University, is giving a course of seven lectures on "The Sources of Religious Insight," at Lake Forest College from November 13 to 19.

At a meeting of the Senn Club, October 31, plans were extended for a bronze statue to the memory of Dr. Nicholas Senn, to be placed in Lincoln Park. The statue is to cost $25,000, and the funds are to be sought by subscriptions from physicians.

At a meeting of the Academy of Sciences in Havana, on October 13, Dr. Juan Guiteras delivered an oration on the life and work of Dr. Carlos Finlay. At the conclusion of the address Dr. Santos Fernandez spoke briefly on the same theme and urged the erection of a monument to Finlay in the Havana Morro.

Professor St. Lindeck, of the Reichsanstalt and editor of the *Zeitschrift für Instrumentenkunde,* died on October 21, aged 47 years. Dr. Lindeck was in America at the

Columbian Exhibition with von Helmholtz, and was a member of the International Conference on Electrical Units and Standards, which met in London in 1908.

The death is announced at the age of seventy-four years of the Rev. Henry C. McCook, D.D., a leading Presbyterian clergyman of Philadelphia, known also for his popular scientific publications on entomology.

Dr. Antoine Blatin, former professor of physiology at the Ecole de médecine de Clermont, has died at the age of seventy-two years.

The twentieth annual meeting of the American Psychological Association will be held in Washington on Wednesday, Thursday and Friday, December 27, 28 and 29. Hotel headquarters will be at the Ebbitt House. A symposium on the demarcation of the distinct difference between "Instinct and Intelligence" will be opened by Dr. Marshall. Professor Herrick, Professor Yerkes and Professor Judd have already completed the preparation of their contributions to this symposium. Papers on the experimental study of animal behavior will be read before a joint session with Section F of the American Association for the Advancement of Science and the society will unite with Section L for one session devoted to reports of research in educational psychology. The committee on experiments useful in teaching psychology (class and home experiments) will have some definite results of their year's work to present to the association. Plans are brewing for a program on psychology in its relations to medical education. The proposal meets with the hearty approval of such representative educators as Drs. Adolf Meyer, Donaldson and Prince. An exhibit of apparatus is being arranged.

The American Physiological Society will hold its twenty-fourth annual meeting in Baltimore and Washington during convocation week, beginning December 26, 1911. The society will hold joint sessions in Baltimore with the American Society of Biological Chemists and with the American Society for Pharmacology and Experimental Therapeutics, and in Washington with Section K, of the American Association for the Advancement of Science. In Baltimore the place of meeting will be the Johns Hopkins Medical School.

The tentative program for the sessions of Section D at the Washington meeting of the American Association for the Advancement of Science in convocation week is as follows:

Wednesday, December 27.
 Miscellaneous papers.

Thursday, December 28.
 Morning session. Papers on aeronautics and related topics.
 Afternoon session. Address of Professor A. Lawrence Rotch, retiring vice-president of the section. Subject: "Aerial Engineering."

Friday, December 29.
 Morning and afternoon sessions. Papers on highway engineering.

Saturday, December 30.
 Highway inspection trips, in charge of Professor A. H. Blanchard.

Members of the American Association for the Advancement of Science expecting to contribute to the program of Section D should so advise G. W. Bissell, secretary, East Lansing, Mich., as soon as practicable and preferably not later than December 1. Blanks for titles and abstracts will be furnished by the secretary on request.

The annual meeting of the Association of American Agricultural Colleges and Experiment Stations, will be held at Columbus, O., from November 15 to 17. Societies meeting in affiliation are the Society for the Promotion of Agricultural Science, American Society of Agronomy, American Farm Management Association and the American Society of Animal Nutrition on November 13 and 14; American Association of Farm Institute Workers, November 13 to 15, and Association of Feed Control Officials of the U. S., November 17 and 18.

Mr. Andrew Carnegie has turned over $25,000,000 in first mortgage bonds of the United States Steel Corporation to the Carnegie Corporation of New York, the body which was incorporated by the legislature on June 9 of

the present year for the purpose of taking over Mr. Carnegie's work in connection with educational institutions, libraries and hero funds. The incorporators are Andrew Carnegie, Elihu Root, William N. Frew, Henry S. Pritchett, Robert S. Woodward, Charles L. Taylor, James Bertram and Robert A. Franks. Mr. Root is head of the Carnegie Peace Foundation, Mr. Frew is president of the board of trustees of the Carnegie Institution of Pittsburgh. Mr. Pritchett is president of the Carnegie Foundation. Mr. Woodward is president of the Carnegie Institution at Washington. Mr. Taylor is president of the Carnegie Hero Fund. Mr. Franks is president of the Home Trust Company. Mr. Bertram is Mr. Carnegie's secretary. The objects of the corporation are "receiving and maintaining a fund or funds and applying the income thereof to promote the advancement and diffusion of knowledge and understanding among the people of the United States, by aiding technical schools, institutions of higher learning, libraries, scientific research, hero funds, useful publications and by such other means as shall from time to time be found appropriate therefor." The incorporators have elected officers as follows: Mr. Carnegie, *president;* Senator Root, *vice-president;* Mr. Franks, *treasurer,* and Mr. Bertram, *secretary.*

UNIVERSITY AND EDUCATIONAL NEWS

As a result of the action of the Michigan Board of Tax Equalization, it is estimated that the University of Michigan will in the future receive $208,000 more from the state for its maintenance than heretofore. The total valuation of property in the state has been increased by approximately $555,000,000, and the three eighths mill tax will yield an annual income for the university of $858,000, instead of $650,000 as formerly.

THROUGH the death of Joseph Pulitzer the $1,000,000 which he had given Columbia University to found a School of Journalism has been automatically released. A meeting of the advisory board named in the agreement between the university and Mr. Pulitzer will be called in a few weeks. It is understood that if the work of the school during the first three years is regarded as satisfactory by the board, it will receive a further endowment of $1,000,000.

AT the last session of the legislature of the state of Minnesota among other appropriations for the university was one which will net $5,000 for each of the two years before the next legislature assembles to be voted exclusively to research, not agricultural, since that is cared for otherwise. When the question of the allotment of this sum was to be met, a research committee drawn from the faculty of the graduate school was constituted for the purpose of passing upon the applications for aid in research and recommend to the president and regents what allotments they should make from this fund, as well as drawing up regulations under which the expenditures should be made.

BY the will of Miss Phoebe Caroline Swords, of New York City, $41,000 is bequeathed to St. Luke's Hospital and $20,000 to Columbia University, of which $10,000 is for a scholarship at the College of Physicians and Surgeons.

THE plan of a joint committee of trustees and faculty to consider the "larger questions of educational administration" has been adopted by the trustees of Trinity College.

IN an article in the issue of SCIENCE for October 27, on "The Number of Students to a Teacher in the State Colleges and Universities," by Professor C. H. Handschin, the figures for the University of Minnesota are given as 26.1. We are requested to state that Minnesota's enrolment for 1910–11 was 6,037, which includes 72 correspondence students. Omitting these, the total is 5,955 students. The total number in the faculty is 455. This includes 65 who rank as assistants, 34 of this number being clinical assistants in the department of medicine who receive no pay. In the 455, who are included in the staff of instruction, are 89 who do not receive any compensation. These are mainly in the college of medicine and surgery. Omitting these 89, the faculty numbers 366. 5,955 divided by 366 is

16.2 which indicates the maximum number of students per instructor. Using the larger number, 455, as the number in the faculty, the number of students to each member is 13.

At a meeting of the Alumni Association of the University of Texas in June Mr. Will C. Hogg offered to raise between twenty-five and fifty thousand dollars annually for the next five years as a publicity fund. Within the past four months Mr. Hogg has collected a sum aggregating $147,625, which he has put at the disposal of an executive committee consisting of President Sidney E. Mezes, E. B. Parker, president of the alumni, and the president of the board of regents, Clarence Ousley. As has already been stated in Science, the objects of the movement are to stimulate higher education; to secure the counsel of distinguished educational workers in the United States and Europe; to investigate and advise the people what the scope of higher educational institutions should be, and what methods and means of maintenance should be provided.

The University of Washington celebrated its fiftieth anniversary last week. On "University and State Day" addresses were delivered by Dr. Kendric Charles Babcock, of the office of the United States Commissioner of Education; President Campbell, of the University of Oregon; President MacLean, of the University of Idaho, and Governor Hay, Superintendent of Public Instruction Dewey and Judge Chadwick, of the state supreme court. On the following day Chancellor Samuel Avery, of the University of Nebraska, and President James H. Baker, of the University of Colorado, delivered the principal addresses.

Dr. F. L. Stevens, of the North Carolina College of Agriculture, has accepted a position as dean of the College of Agriculture of the University of Porto Rico located at Mayaguez. He will take up his residence and begin the organization of the Agricultural College at that place on January 1, 1912. It is the intention to establish in connection with the Agricultural College and under the directorship of Dr. Stevens, a Tropical Botanical-Zoological Laboratory.

Dr. William F. R. Phillips, formerly dean of the medical department of George Washington University, has been elected professor of anatomy in the School of Medicine, University of Alabama, Mobile, and has moved to that city.

Mr. John E. Boynton, B.S. (Wisconsin), for several years assistant professor in the University of Iowa, has been appointed professor of mechanical engineering at Lafayette College.

Mr. Prevost Hubbard, chief of the Division of Roads and Pavements of the Institute of Industrial Research, has been appointed lecturer in engineering chemistry at Columbia University. He will conduct the courses in bituminous materials given in connection with the graduate courses in highway engineering.

At the West Virginia University appointments have been made as follows: C. R. Jones, professor of engineering, to be dean of the college of engineering; Rollin P. Davis, of the college of civil engineering, Cornell University, assistant professor of structural engineering; C. R. Titlow, of the extension department of the Ohio State University, director of agricultural extension; J. B. Grumbein has been advanced to assistant professor of mechanical engineering; Robert H. Chandler, of Sommerville, Mass., has been appointed as instructor of woodwork and foundry.

Mr. Bruce W. Benedict, for several years in the motive power department of the Atchison, Topeka and Santa Fe Railway, has been appointed director of the shop laboratories in the department of mechanical engineering at the University of Illinois.

Dr. Ralph A. Hamilton has been appointed professor of histology and embryology in the school of medicine of Georgetown University.

Mr. George Frederick Charles Searle, M.A., F.R.S., has been elected to a fellowship at Peterhouse, Cambridge. Mr. Searle was formerly a scholar of the college, and has been demonstrator of experimental physics at the Cavendish Laboratory since 1888 and university lecturer in experimental physics since 1900.

DISCUSSION AND CORRESPONDENCE

A NEW TOY MOTOR

I made of wood a nacelle about two inches long, pointed at one end and open at the other, shaped like a skiff without a stern-board. It was rendered water-repellent by a slight coating of paraffin. A slice of soap was fitted into the stern and the boat thus completed was placed on still water in a bath tub. As was anticipated, the craft began to move off as soon as the water came in contact with the soap. After gathering way it reached a velocity of a couple of inches per second. Sometimes the course was nearly straight, sometimes erratic, as might have been expected in the absence of steering apparatus.

The power is derived from the potential energy of the surface water-film set free by the diminution of surface tension, this reduction being due to solution of the soap.

If the whole immersed surface of the boat is allowed to become soapy, converse conditions set in. The boat is then approximately in stable equilibrium in the center of an area of low surface tension and, if displaced by a half an inch or so, may return to its place almost as if anchored.

It seems *a priori* improbable that the means of locomotion illustrated by this little motor-boat has not been utilized in nature. If, for example, the ripe seeds of a plant growing in shallow, still water were boat-shaped and provided with a store of soluble material at the blunt ends, they might attain a much wider dissemination or more varied environment than that open to similar seeds not fitted to utilize the potential energy of surface tension.

I am not aware that such seeds have been described, but my acquaintance with botanical literature is of the slightest. If the facts are already known this note may assist to diffuse a knowledge of them.

George F. Becker

Washington, D. C.,
October 27, 1911

A COMMON ERROR CONCERNING CECIDIA

It is well known that many errors which are recognized by scientific workers are repeated in various publications, including text-books, until they threaten to become as thoroughly engrafted into our literature as the George Washington hatchet and cherry-tree story, although not nearly so useful. Among these errors is the prevailing opinion that vegetable galls which are due to insects are the result of an irritating fluid secreted by the female parent insect at the time of ovipositing. Many of our scientists cling to this ancient theory as tenaciously as the young American clings to the wonderful hatchet story.

The latest outbreak is in the recent edition of the Encyclopædia Britannica, in which, under the heading "Galls," it is said that "The exciting cause of the hypertrophy, in the case of typical galls, appear to be a minute quantity of some irritating fluid or virus, secreted by the female insect, and deposited with her egg in the puncture made by her ovipositor in the cortical or foliaceous parts of plants. This virus causes the rapid enlargement and subdivision of the cells affected by it, so as to form the tissues of the gall. Oval or larval irritation also, without doubt, play an important part in the formation of many galls."

In consideration of this prevailing idea it may be worth while to review our knowledge on this point. This theory was first advanced by Malpighi in his "De Gallis" (1686), who believed that the female parent secreted a poison when she deposited the egg and that this caused a fermentation of the plant acid which stimulated the plant cells and thus caused the gall. This theory was repeated almost without question until the latter part of the last century; Réaumur accepted it but thought that the egg might have some thermal effect and that the character of the wound might also be a factor; Dr. Derham said it might be "partly due to the act of the plant, and partly to some virulency in the juice or egg, or both, deposited in the vegetable by the parent animal; and just as this virulency is various according to the difference of its animal, so is the form and texture of the gall excited thereby"; Darwin expressed the opinion that galls were caused "by a minute atom

of the poison of the gall insect"; and Sir James Paget as late as 1880 said that "the most reasonable, if not the only reasonable theory, is that each insect infects or inoculates the leaf or other structure of the chosen plant with a poison peculiar to itself." In brief, the theory of a stimulus due to a chemical substance injected into the plant by the female at time of egg laying was the accepted view of scientists from the publication of Malphighi's "De Gallis" in 1686 until about thirty years ago. However, from about 1877 to 1882 there appeared a number of important publications by Dr. Hermann Adler and Dr. M. W. Beyerinck which in a great part disproved the previously almost undisputed theory. From this time the study of cecidology became a growing factor in plant physiology and plant pathology.

Beyerinck's work indicated that the fluid injected by mother insect was tasteless and odorless and not perceptibly irritating when injected under the skin and that it probably served only as an antiseptic dressing to the wound of the host plant. The work of both authors indicated that there was no cell activity on the part of the host plant leading to gall formation until the larvæ emerged from the egg. Adler, as a result of a careful study of the galls of *Neuroterus læviusculus* and *Biorhiza aptera,* states that immediately following the emerging of the larvæ from the egg that there is a rapid division of the cells of the host plant due to the attacks of the larvæ. He was inclined to believe this due to the influence of salivary excretions. However, Adler also made a study of the Galls of *Nematus vallisnierii* on *Salix amygdalina,* which is produced immediately following oviposition and is fully developed before the hatching of the larvæ. This is probably the only well authenticated case of gall formation previous to the hatching of the larvæ and is undoubtedly the exception rather than the rule for gall builders.

It is well known that the gall makers belonging to the Cecidomyidæ, Aphididæ and Acarina do not puncture the plant tissues with the ovipositors and that the young insects are, strictly speaking, never within the tissues of the host plant but are surrounded by plant growths due to an irritation by their own mouth parts.

At the present time there is no proof, except in the case of *Nematus vallisnierii* that the gall is due to a secretion from the mother insect. Whether due to a chemical or a mechanical irritation of the young insect are questions with as much circumstantial evidence for the one as for the other.

It may be added that the studies of the past few years on cecidia due to bacteria, myxomycetes, fungi and nematodes indicate certain striking resemblances to the zoo-cecidia and we have reason to believe that further researches into the anatomy and physiology of these various groups of hypertrophied structures will lead to valuable contributions to our knowledge of cecidology.

Mel. T. Cook
Agricultural Experiment Station,
Newark, Delaware

THE AIR-BLADDER OF THE CLUPEOID FISHES

In a recent letter (Science, October 13) Dr. E. C. Starks has suggested that the posterior opening of the air-bladder in *Clupea harengus* needs further investigation. This opening was originally described by Weber in 1820, was rediscovered by Bennett in 1880, and was again described by Dr. Ridewood in 1892 in a paper entitled "The Air-bladder and Ear of British Clupeoid Fishes" (*Journ. Anat. Phys.*, XXVI., pp. 26–42). Dr. Ridewood devoted a special section to the posterior opening to the exterior; he showed that it was present not only in *Clupea harengus,* but in *C. pilchardus, C. sprattus, C. alosa* and *Engraulis encrasicholus.* In *Clupea finta,* however, he found that the air-bladder tapered to a point posteriorly and did not open to the exterior.

C. Tate Regan
British Museum (Natural History),
London, S. W.,
October 30

TRANSFERENCE OF THE TERM "GENOTYPE"

To the Editor of Science: Science for October 13 just to hand contains announcement of Professor Johannsen's Columbia Lectures. Permit us to protest again in the strongest possible manner against this unwarranted transference of the term "genotype" and change of its meaning. Professor DeVries set a bad example by using "mutation" in a new sense. Is there to be no limit to this rough riding over workers in other branches of biology?

F. A. Bather,
W. T. Calman
British Museum (Natural History),
London, S. W.,
October 23, 1911

SCIENTIFIC BOOKS

STEINMETZ'S ENGINEERING MATHEMATICS

This book is based upon a lecture course given for some years by the author to students of electrical engineering at Union College. The title might well lead one to expect that here at last is a book by a competent authority presenting the mathematical foundation which in his opinion should constitute a part of the training of every engineer. But upon reading the preface expectations and hopes of this nature are abruptly terminated when the reader learns from the summary paragraph:

"Thus the following work is not intended as a complete course in mathematics, but as supplementary to the general college course of mathematics, or to the general knowledge of mathematics which every engineer and really every educated man should possess."

The book is even further limited in its scope than is indicated by the quoted paragraph. For it is largely devoted to the particular sort of mathematics which is of great service to the electrical engineer only. In spite of this the mastery of its contents would unquestionably not be a useless accomplishment to the student in any branch of engineering.

The first chapter is devoted to an elementary exposition of the properties of the general number or complex quantity and the chapter is replete with graphical illustrations. A particular feature of this chapter showing the usefulness of the theory developed is the discussion of the steam path in a turbine.

In the second chapter is given a discussion of series of the types $1 + x + x^2 + x^3 \ldots$ and $1 - x + x^2 - x^3 + \ldots$, designated as potential series. Examples from electrical engineering problems are given to illustrate the applicability of such series to the development of certain functions. The properties of the exponential function are adequately treated and the subject of differential equations is briefly touched upon.

The third chapter treats quite extensively of trigonometric functions and series. Interesting illustrative problems are discussed.

Chapter IV. deals in an elementary but sufficiently comprehensive manner for the purposes of the engineer with the subject of maxima and minima of functions. Numerous practical examples in electrical engineering are worked out numerically. There is also given a short discussion of the method of least squares with an illustrative example from the theory of the induction motor.

Methods of approximation are treated in Chapter V. This subject, an art in itself, is one which is rarely discussed explicitly in books on mathematics or engineering.

Chapter VI. contains an extensive discussion of the subject of empirical curves and the methods of obtaining analytical equations to fit them.

The eighth chapter and the final one is devoted to methods of numerical calculation. A thorough knowledge of the subject matter of this chapter and that of the two preceding chapters obviously should be a part of the equipment of every computing engineer, electrical or otherwise. A striking feature of the book is the author's continual insistence throughout upon the importance to every engineer of a thorough mastery of the sadly neglected art of numerical computation.

There are two appendices, one containing notes on the theory of functions, the other tables of exponential and hyperbolic functions.

As is common in a first edition, there are numerous typographical errors, but usually they are of such nature as not to cause serious ambiguity to the reader.

The book is published by the McGraw-Hill Book Company, of New York.

A. P. Wills

Geometrie der Kräfte. By H. E. Timerding. Leipzig, Teubner (Teubners Sammlung). 8vo. Pp. xi + 381.

This book is an outgrowth of the author's article "Geometrische Grundlegung der Mechanik eines starren Körpers," in the Enzyklopädie der Mathematischen Wissenschaften (Band IV., 1, pp. 125–189), which consisted principally in an account of the Ball theory of screws. The volume under review goes far beyond that article in its scope, both in dealing with the mechanics of deformable bodies, and in giving presentations of the vector theory and of line geometry. On the other hand it is limited by the desire to present the geometry of forces as an independent subject and to avoid a general treatment of mechanics as such, especially since Webster's treatise appeared as a member of the same series of texts.

The geometry of motion, or kinematics, is better known as a distinct subject than is the geometry of forces. In general the two subjects have similar motives and enjoy similar advantages: both seek to present a purely abstract geometrical analysis of mechanical concepts, and each is suggestive and instructive to the student of geometry as well as to the student of mechanics.

The author seeks to unify and complete the labors of his predecessors—Varignon, Poinsot, Chasles, Moebius, W. Thompson, Ball, Study, and others—to form a symmetrical whole and to create a finished theory of forces "disassociated from all physiological, physical, and metaphysical concepts," which shall apply to the kinetics and statics of rigid bodies, and to the statics of deformable bodies.

The first five chapters are devoted to the theory of vectors, following chiefly Grassman and Hamilton. The notation employed differs from that of each of these writers, and also from that of Gibbs, thus adding another to the many existing notations.[1] The ideas developed in these chapters are used to define the concepts moment of a vector, rotor, dyname; but otherwise little use is made of the vector theory. The author defends this as against prospective criticism, on the ground that the results can be reached by methods of analytic geometry, and that the extensive use of the vector theory would render the work less accessible to beginners. Under the circumstances a complete presentation of the vector theory might have been dispensed with altogether.

The following chapters treat of instantaneous rotation and of forces and dynames. The latter term was introduced by Plücker[2] and has been employed extensively by Study[3] and others, to denote the geometrical concept which corresponds to either a twist or a wrench in Ball's theory.

Chapter VIII. is an elementary presentation of line geometry, which the author, following many others[4] makes his fundamental link between geometry and mechanics. He also sets a bound to geometrical developments as a whole by restricting himself to this topic and its applications.

After a chapter on equilibrium, the theory of screws is presented in detail in six chapters, which form the kernel of the entire book, and indeed constituted the motive for the original project. The chapter on the cylindroid is particularly worthy of notice.

Two chapters on deformable bodies extend the theory beyond the realm of rigid bodies—an extension on which the author lays great weight in the preface.

The remainder of the book deals with the mechanical concepts in distinction to the

[1] See Wilson, *Bulletin of Amer. Math. Soc.*, Vol. 16 (1910), p. 415.

[2] *Philosophical Transactions*, 156, 1866; "Works," I., p. 548.

[3] "Geometrie der Dynamen," Leipzig, 1903.

[4] See, *e. g.*, Klein, *Mathematische Annalen*, Vol. 4.

purely geometrical work that precedes. Here again a treatment of deformable bodies and of elasticity is added to the more usual treatment of the mechanics of rigid bodies.

As a whole the work seems a most satisfactory compilation, to which the author has added materially by careful readjusting and supplementing existing work. The bibliography and references are good.

In being late, the present review has the advantage of referring the readers to a number of admirable reviews already in print; among those most readily accessible are: R. S. Ball, *Nature,* LXXXI., July, 1909, p. 34; Longley, *Bull. Amer. Math. Soc.,* XVI., 1910, p. 493; *Revue Generale des Sciences,* 21, 1910, p. 75. Of these, that by Ball in *Nature* is of course the most interesting on account of the close relation he holds to this theory.

E. R. HEDRICK

GÖTTINGEN, GERMANY,
August, 1911

Material for Permanent Painting. A Manual for Manufacturers, Art Dealers, Artists and Collectors. By MAXIMILIAN TOCH. New York, D. Van Nostrand Co. Pp. 208. Price, $2.00.

It would seem that Mr. Toch had gotten into this small compass practically all that an artist need know about his materials from the standpoint of permanency. Judging from the author's name, one would expect a work dealing solely with pigments: only about half of the book is so employed, the remainder consisting of interesting chapters on the history of painting, preparation of canvasses and other foundations, the causes and remedies for cracking of paintings, their renovation, and the oils and other media used in their production. The articles on the photochemical effects of light and the proper use of madder are especially noteworthy and merit careful study.

Some slight slips in proof reading or unusual spellings are in evidence as, quick silver (two words), cinibar, sulphureted, tuscan, Va*n*quelin and Gui*n*et; but these will doubtless disappear in the next edition. Indian yellow is stated to be made from camel dung, whereas the commonly accepted source is cow urine.

The work admirably fills a long-felt want and a good knowledge of its contents should be part of the equipment of every painter.

A. H. GILL

NOTES ON METEOROLOGY AND CLIMATOLOGY

THE Savannah-Charleston hurricane of August 27–28, 1911, has been made the subject of a special report by the United States Weather Bureau. This storm resulted in the loss of 17 lives, while the damage to property was estimated at $1,000,000. The synoptic weather charts which form a part of the bulletin show that the storm lingered off the coast for four days before its approach was detected on shore. Though no wireless reports concerning the hurricane had been received, the weather officials in the two cities mentioned observed the characteristics which usually precede such a storm on the morning of August 27. Acting upon orders from the Washington office, they immediately sent out cautionary warnings. The wind continued to increase, and twelve hours later reached a velocity of 106 miles per hour in Charleston. The center of the hurricane reached the coast near Savannah at 8 A.M. of the 28th, the barometer at that station reading 29.02 inches. Moving thence inland, it passed through eastern Georgia with diminishing intensity, recurved over North Carolina, on a course east-northeastward, and passed to sea off the New Jersey coast. It is a noteworthy fact that no storm of tropical or semi-tropical origin has reached the southern or eastern coasts of the United States without warning since September, 1893, when a disturbance of marked intensity devastated the Louisiana coast. At the present time the Weather Bureau is looking forward to the establishment of a service whereby observers regularly employed aboard coast-wise vessels would report weather conditions twice daily to the central office, and thus to provide early infor-

mation concerning the approach of these destructive storms.

THROUGHOUT the greater part of the United States and Europe the excessive heat of the past summer will be long remembered, new maximum temperatures having been observed in many widely separated places. Unprecedented temperatures of 98° and 99° F. were observed at Blue Hill Observatory (635 feet above sea-level) on six days during the early part of July, while the mean temperature for the month, 74.5° F., was the highest experienced in the vicinity in 63 years, which is the length of the record. At the Royal Observatory, Greenwich, new records have also been established. There the mean temperature for the six months, April to September, inclusive, was 60.7° F., the highest since 1841. The mean for the three months June, July and August was 66.1° F., which is 4.9° in excess of the average for the past 70 years, and 1.0° higher than any previous summer on record. On August 9 a temperature of 100° F. was observed at Greenwich, this being 3.0° higher than any previous record at the Royal Observatory since 1841. The mean maximum temperature for August was 81.1° F., another new record. On July 22, August 4 and 9, a black-bulb thermometer exposed to the sun's rays showed a temperature exceeding 160° F.

UNDER the supervision of its director, Professor R. F. Stupart, the Canadian weather service has recently been carrying on experiments with registering balloons. These ascensions, the first of the kind in Canada, were made from Toronto and Woodstock. Of the balloons sent up enough were recovered to make the experiments successful. Several of the balloons entered the region of the upper temperature-inversion, and uniformly good heights were attained, the balloon sent up September 9 reaching a height of more than 14 miles. On July 5, the day on which new maximum temperature records were established in many places, the meteorograph on leaving the ground at Woodstock recorded a temperature of 81° F., while at a height of 9.4 miles it was — 93° F. Above the latter level the temperature increased slowly with height.

"DIE Winde in Deutschland," by Dr. Richard Assmann, director of the Lindenberg Aeronautical Observatory, is a volume prepared at the request of a German aeronautical society. Based upon more than a million ground and free-air observations of wind velocity and direction, it was designed to serve as a meteorological guide book for dirigible balloon transportation in that country. Tables and diagrams set forth in great detail the varied wind data of which an aeronaut must have a knowledge. For Lindenberg, where a kite flight or a balloon ascension has been made every day without a single exception since 1905, the velocities and the frequencies of winds for each of the various directions at every 500-meter level up to 4,000 meters are shown by means of wind-roses. From a meteorological as well as from an aeronautical point of view the volume is a valuable book of reference.

"WEATHER Science," an "elementary introduction to meteorology," by Mr. F. W. Henkel, has recently appeared. This volume, consisting of 336 pages, is not designed as a textbook, but as a popular work it is very readable indeed. The few slight inaccuracies which occur will doubtless be overlooked by the average reader. This is the first contribution to meteorology made by the author, who is an English astronomer. Dr. Shaw, the head of the English weather service, has also completed a book, now in the hands of a publisher, called "Forecasting Weather." This volume, written primarily for aeronauts, is based upon the results in dynamic meteorology obtained by the Meteorological Office during the last ten years. A second edition of Mr. H. G. Busk's "What will the Weather be?" has also made its appearance.

FOREST Service Bulletin No. 86 contains a paper, "Windbreaks: their Influence and Value," by Mr. Carlos G. Bates, which deals with a problem that is of interest from the point of view of meteorology, as well as of forestry and agriculture. Windbreaks, he

says, may be profitably employed in much of the agricultural portion of the United States. The distance at which the effect of the trees may be felt averages twenty times their height, although absolute protection of a crop such as corn, in a wind with a velocity of 50 miles per hour, can not be expected beyond a distance of from six to eight times the height of the windbreak. Partial protection is given over a distance of from twelve to fourteen times the height. In extreme cases the efficiency of a windbreak in checking evaporation from the soil may amount to 70 per cent. of the moisture ordinarily lost. Protection in this respect is appreciable for a distance equal to five times the height of the trees in the windward direction, and fifteen or twenty times the height leeward. The absorption of soil moisture by the roots of the trees may in the case of an orchard be appreciable, but need not result in real damage. There is little basis for the belief that windbreaks sap the fertility of the soil. The trees' absorption of soil moisture may, however, reduce the activity of the nitrifying bacteria and cause temporary sterility in the zone of root influence. The effect of a windbreak upon temperature in the region of its influence is much greater than is commonly supposed. The diurnal range in temperature in an area protected by a windbreak is nearly 9° F. greater than where the air circulates freely. The effect of the superheating of both air and soil in a protected zone is favorable to crops which must begin growth at a time when the heat is barely sufficient for generation. An abstract of the book prepared by Mr. Findley Burns appears in the *Journal of the Washington Academy of Science,* Vol. I., No. 3.

Two recent studies of the rainfall in special regions are noteworthy. With characteristic German thoroughness, Dr. Hellmann and G. v. Elsner have completed an investigation of certain heavy rains in the valley of the Oder during the years 1888–1903, inclusive, and their relation to the summer high water of that river. The research is published in two volumes, a descriptive text and an atlas, the latter consisting of 55 large colored plates showing in detail the distribution of these rains in northern Germany and the meteorological conditions which accompanied them. "The Rains of the Nile Basin" is a report by J. I. Craig, of the Survey Department, Egypt, based upon eleven years' observations. The Nile flood has been of great moment to the residents of that valley from remote antiquity. The author now says "there are hopes that within a few years the prediction of the main features of the flood may be embodied in an algebraic formula such as has already been obtained for the Indian monsoon by Mr. G. T. Walker." It is now well established that "the rainfall in Abyssinia during the flood months is due almost entirely to the precipitation caused by diurnal ascensional movements acting on the southwesterly current which again is kept at the point of saturation by its ascent on to the Abyssinian tableland." The latter current has been traced backward across the Sudan plains, and the watershed between the basins of the Nile and Congo, and thence down the basin of the latter to the South Atlantic.

A COMPLETE summary of the free air data obtained at Mount Weather for the three years ending June 30, 1910, appears in Vol. IV., Part 2, of the *Bulletin of the Mount Weather Observatory.* The aeorological work is in charge of Dr. William R. Blair, who prepared the summary. On 980 of the 1,096 days of the period, 1,013 ascensions were made—896 by means of kites and 117 by means of captive balloons. Air temperature, air pressure and wind direction aloft were observed, in addition to noting weather conditions and keeping the usual continuous meteorological records at the earth's surface. The temperatures have been grouped by months and by seasons, and the means have been computed for levels 250 meters apart up to 7,250 meters above sea level. Several other valuable tables summarizing the data obtained for the various other elements are included, and their relation with reference to the centers of cyclones and anticyclones are also shown. Previously derived conclusions are verified by means of the new data. Since the beginning of this period the

aerological work has been extended so that it is now carried on daily, including Sundays. Another innovation at Mount Weather is that of obtaining wind velocity aloft. The series of nine soundings of the free air made in two days is probably unprecedented in the annals of meteorology. This occurred on September 12 and 13 last, when from 6:37 in the morning of the first day to 1:06 in the afternoon of the next day the nine kite flights were made one after another, without a pause between them. During the last of these flights a west-northwest wind with a velocity of 69 miles per hour was successfully navigated by a kite at a height of 10,177 feet above sea level.

The "spectre of the Brocken" is a phenomenon usually observed only from mountain summits. But for two hours on the night of August 6 it was observed by the writer from the top of the Blue Hill Observatory tower, the height being about 700 feet above sea level. Fog, which had been brought in from Boston Harbor by a light easterly wind, arrived at Blue Hill shortly before eight o'clock. Its upper surface, which was very distinct, was about at the level of the upper windows of the tower. The moon, about three-quarters full, was well above the horizon, and a few scattered cirrus streamers were the only high clouds visible. From the top of the ladder on the anemometer poles the surface of the fog stratum had the appearance of a wavy sheet of water. Directly opposite to the moon the observer could see, at an estimated distance of 75 feet, a dark image of himself enlarged about three times his natural size. The image was surrounded by a white light which faded away at its edges, leaving a dark space between it and a broad colorless circle, sometimes called "Ulloa circle" or "white rainbow." The circle was complete and appeared to have a radius of about 22°. When the observer moved the whole apparition moved likewise, proving it to be an entirely subjective phenomenon. It disappeared later when the fog deepened, rendering the moon invisible.

Andrew H. Palmer

Blue Hill Observatory,
November 1, 1911

SPECIAL ARTICLES

THE LIFE HISTORY OF A PARASITIC NEMATODE—HABRONEMA MUSCÆ

Fifty years ago, from Bombay, India, the late H. J. Carter[1] reported the discovery of nematodes parasitic in the house fly, giving them the name of *Filaria muscæ,* and suggesting that their investigation might throw light on the life history of the guinea-worm. In the same year Diesing[2] transferred Carter's species to the genus *Habronema,* making it the type. Carter's description and figures, though not accurate in all respects, particularly in the interpretation placed on certain details of structure, are sufficient for the recognition of the species. Subsequently to Carter, several writers have mentioned the presence of nematodes in the house fly, in some cases identifying them with Carter's species, in other cases being apparently unaware that the species had ever been described or named. Leidy[3] noted the occurrence of *Habronema muscæ* in about 20 per cent. of flies examined at Philadelphia. Further than occasional records of the occurrence of *Habronema muscæ* in flies, practically nothing up to the present time has been added to Carter's account of the worm, though it has long since become known that this parasite has nothing to do with the guinea-worm.

In the summer of 1910, the present writer found *Habronema muscæ* fairly common in house flies caught at Washington, D. C. The fact that this nematode occurred in the larval stage in flies suggested two alternative hypotheses, first, that the adult was a free living form, second, that the adult occurred parasitic in some host other than the fly. No evidence favoring the first hypothesis was obtained, as the nematodes from flies when placed in various media such as water, damp

[1] *Ann. and Mag. Nat. Hist., Lond.,* 3 s. (37), v. 7, January, 1861, pp. 29–33, pl. 1*A*, Figs. 1–4.

[2] *Sitzungsb. d. k. Akad. d. Wissensch.,* Wien, Math.-naturw. Cl., v. 43, 1 Abt. (4), pp. 273–274, 1861.

[3] *Proc. Acad. Nat. Sc. Phila.* [v. 26, 3 s., v. 4] (2), April-September, 1874, pp. 139–140.

earth, horse manure, etc., invariably died without showing any indication of further development.

Further observations on *Habronema muscæ* were made during the summer of 1911, when it was found commonly present in house flies in Colorado and Nebraska. A series of stages in the development of the parasite was obtained by examination of various stages of the fly from larva to imago, and it became evident that the fly acquires its infection during its larval stage. This suggested the hypothesis that *Habronema muscæ* is the larval stage of a nematode parasitic during its adult stage in the horse, inasmuch as horse manure is a favorite breeding place of the house fly. The structure of the esophagus of *Habronema muscæ* suggested the further hypothesis that this parasite belonged either to *Spiroptera megastoma* or to *S. microstoma,* nematodes which occur in the stomach of the horse.

Ordinarily the testing of the hypothesis that *Habronema muscæ* is the larval stage of a horse parasite would require properly controlled feeding experiments, but, in September of the present year, the problem of the identity of the parasite was solved in another way. The stomachs of two horses were examined shortly after death. In one of them, a few adult nematodes were found which, from their naked eye appearance, closely resembled *Spiroptera microstoma.* In the other, a large number of the same species of adult worms was found, and in addition numerous smaller nematodes of various sizes. Microscopical examination of the worms collected from these horses revealed the presence of a complete series of stages in the development and growth of a single species of nematode from larva to adult, only the one species being represented, except that a few individuals of a species of *Trichostrongylus* were also present. The smallest forms corresponded perfectly to the nematodes found in adult flies, and the correctness of the hypothesis that *Habronema muscæ* is the larval stage of a nematode parasitic during its adult stage in the horse, was thus confirmed. The adults of *Habronema muscæ,* though very similar to, proved to be different from, *Spiroptera microstoma,* most noticeably in the structural details of the head and pharynx, vagina of the female and bursa and spicules of the male. The spicules alone present sufficient evidence of a specific difference in the two forms, as will appear from the following measurements:

In *Habronema muscæ* the left spicule measures about 2.5 mm. in length and about 5 μ in diameter near its middle, the right spicule about 500 μ in length by about 10 μ in diameter near its middle. In *Spiroptera microstoma,* or, giving this species its correct generic designation, in *Habronema microstoma* the left spicule measures about 800 μ in length by about 15 μ in diameter near its middle, the right spicule about 350 μ in length by about 20 μ in diameter near its middle.

The life history of *Habronema muscæ,* as determined by the results of the investigations which have been briefly sketched in the present paper, may be summed up as follows:

A horse infested with the adult worms excretes their embryos in its feces. These embryos enter the bodies of fly larvæ developing in the feces from eggs deposited by house flies. During the development of the fly larvæ and pupæ, the worms with which they have become infested also undergo a process of growth and development, reaching their final larval stage at about the time the flies emerge from the pupal state. Further development of the worms waits upon the swallowing of the infested flies by a horse, in which event the life cycle becomes completed by the growth of the worms to maturity.

Of interest to entomologists and sanitarians is the fact that *Habronema muscæ* affords a means of determining with some degree of accuracy what proportion of the flies occurring in a given locality find their breeding place in horse manure, to this extent, that if examination of a considerable number of flies shows that a certain per cent. are infected, it may be safely assumed that at least that percentage of the flies in the locality have developed in horse manure. A percentage obtained in this way would of course probably be considerably smaller that the actual percentage, as

it is unlikely that all horses in the locality would be infested and as some flies even though developing in manure from an infested horse would probably escape infection.

A more comprehensive discussion of *Habronema,* illustrated with figures, will be published at a later date, probably as a bulletin of the Bureau of Animal Industry.

B. H. Ransom
Bureau of Animal Industry,
U. S. Department of Agriculture,
Washington, D. C.

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

The one hundred and fifty-fifth regular meeting of the society was held at Columbia University on Saturday, October 28. The attendance at the two sessions was about forty, including thirty-five members. President H. B. Fine occupied the chair. The council announced the election of the following persons to membership in the society: Professor T. B. Ashcraft, Colby College; Professor Clara L. Bacon, Goucher College; Professor J. M. Davis, State University of Kentucky; Professor W. C. Eells, Whitworth College; Dr. J. L. Jones, Yale University; Professor F. C. Kent, University of Oklahoma; Professor L. C. Plant, University of Montana; Mr. R. E. Powers, Denver, Colo.; Mr. T. M. Simpson, University of Wisconsin; Professor Evan Thomas, University of Vermont; Professor H. C. Wolff, University of Wisconsin; Mr. W. A. Zehring, Purdue University. Nine applications for membership were received.

A list of nominations of officers and other members of the council, to be placed on the ballot for the annual election, was adopted. Provision was made for committees to audit the treasurer's accounts and to make arrangements for the summer meeting to be held at the University of Pennsylvania in 1912. The invitation of the University of Wisconsin to hold the summer meeting and colloquium at that university in 1913 was accepted. It was decided to change the form of the *Annual Register* of the society by omitting all mention under the personal entries of membership in other organizations. A committee was appointed to consider and report to the council a plan for placing the business of the society on a permanent basis.

The following papers were read at this meeting:

A. R. Schweitzer: "On a functional equation."

E. V. Huntington: "A new approach to the theory of relativity."

L. P. Siceloff: "Simple groups from order 2,001 to order 3,640."

H. H. Mitchell: "Determination of the quaternary linear groups by geometrical methods."

G. A. Bliss: "A new proof of the existence theorem for implicit functions."

R. E. Powers: "The tenth perfect number."

E. W. Brown: "On the summation of a certain triply infinite series."

L. L. Dines: "On the highest common factor of a system of polynomials."

R. D. Carmichael: "A generalization of Cauchy's functional equation."

R. D. Carmichael: "Fundamental properties of a reduced residue system mod n."

R. D. Carmichael: "On composite numbers P which satisfy the Fermat congruence $a^{P-1} \equiv 1 \bmod P$."

Edward Kasner: "Differential invariants of infinite order."

B. H. Camp: "Series of Laplace's functions."

N. J. Lennes: "A new proof that a Jordan curve separates a plane."

The San Francisco Section of the society also met on October 28, at the University of California. The Southwestern Section holds its fifth annual meeting at Washington University on Saturday, December 2. The annual meeting of the society for the election of officers will be held at Columbia University on December 27–28. The Chicago Section will also meet in the Christmas holidays.

F. N. Cole,
Secretary

THE AMERICAN PHILOSOPHICAL SOCIETY

Factors affecting Changes in Body Weight: Francis G. Benedict.

The normal human body is continually undergoing changes in weight, graduallly losing weight between meals, and increasing it when food is taken. Very great losses incidental to excessive muscular exercise are chiefly due to variations in the water content of the body. By means of experiments with the respiration calorimeter, it has been shown that a change from a diet with a preponderance of carbohydrates to one with a preponderance of fat may cause a loss in weight amounting to two pounds per diem for three days. Experiments made with diabetics also show large changes, chiefly due to the retention or the loss of water. The gains or losses of body material, chiefly fat, are especially emphasized.

SCIENCE

FRIDAY, NOVEMBER 24, 1911

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

UNIVERSITY ADMINISTRATION AND UNIVERSITY IDEALS

THE development of our American universities is seriously handicapped by the present system of administration. A spirit of chauvinism intolerant of adverse criticism from outsiders, even when directed against obvious defects, is often a prominent factor in determining as well as in limiting the functions of the entire educational system now operative in colleges and universities which remain private corporations. This particular defect is more apparent in our older universities where the bonds of union between alma mater and alumni, which during the early period of development were essential to the life of our colleges, now threaten unless modified and readjusted to impair the growth and vitality of these institutions. Wherever the spirit of progress is felt, the problem of the proper readjustment of the administrative forces of our universities so as to make the most effective use of available resources is, for the moment, a more important question than providing for an increase of revenue. It is not difficult to point out more than one concrete example of the confusion that exists in regard to the relationships of the various departments of administration and the unfortunate state of anarchy sure to arise when a board of trustees whose members are uninformed as to the general progress made in the development of universities suddenly reassumes the powers which through their inertia had temporarily been relegated to president and deans. The results of this unfortunate state of affairs have been that fruitless efforts are made to solve problems requiring the training and special knowledge

possessed only by experts in university affairs.

The administration of our universities is vested in a board of trustees, a corporation, or overseers, president and faculty. The manner in which the members of these boards are selected and the relation they bear to each other is not the result of a carefully thought-out plan, but represents a scheme in development in which opportunism has played the chief part. A serious result of a policy of administration that takes no thought for the morrow is seen in the persistence of a form of government sufficiently elastic not to interfere with the growth of the college, but painfully restrictive when applied to the conduct of affairs in the higher institutions of learning. The form of organization, with but very slight modifications, that was originally adopted in the early history of our colleges, when these institutions were about on the level with our present high schools, is practically in use now and is relatively as effective as would be the wood-burning locomotive in pulling the modern express train. The present relationship between the faculty, trustees and president may be regarded as a haphazard growth, the result of a laissez-faire policy, affording an example of the same sufficient-to-the-day spirit and smug satisfaction with existing conditions that is so common in our institutions, and is well illustrated in the administration of municipal affairs where the immediate exigencies of a given situation are met without any provision for eventualities.

The chief duty of the trustees during the early history of the American colleges was to assist the president in collecting the necessary revenues, while turning to him for instruction in regard to the educational policy of the college. He became not alone their representative and spokesman, but also that of the faculty. The present autocratic position of university executives was created for them by the acts of the trustees in shifting responsibility for the performance of certain duties from their own shoulders to that of the president and deans.

The faculty, to an almost equal degree, is to blame for the undue centralization of power in the executive offices. As a rule, faculties (in common with other legislative bodies long deprived of constitutional rights) as a body, are nihilistic and show little evidence of any capacity for constructive criticism and administration. During the period when the autocracy of the president's and dean's office was rapidly rising, it became a form of lèse-majesté, as it is now, for members of the faculty to communicate their views upon university questions to individual members of the board of trustees. As all direct channels of communication between trustees and faculty are officially closed, the temptation to resort to indirect methods of expression and interchange of ideas is frequently present.

The ease with which the members of the board of trustees transferred their power as well as sense of obligation in the performance of duties to the president plainly showed they did not wish to be troubled unnecessarily by the discussion of educational problems. The lack of sympathetic interest shown by the trustees in the problems of most vital importance in the university life has had two serious consequences. In more than one instance a feeling of distrust and suspicion has arisen between the faculty and trustees, more serious and aggravated in the case of the former body, as they as individuals were directly interested in the progress of events. In the second place the absence of any safety valve or of a channel of direct com-

munication between the two governing boards has given rise within the faculty to a *psychasthenia universitatis*. This psychosis has been produced by the lack of opportunity to discuss the larger problems of the university, and as always happens to those suffering from forms of mental repressions, or of living in cramped intellectual quarters, the tendency to indulge in petty recriminations and to be resentful of criticism has occasionally assumed alarming proportions with some of the characteristics of an epidemic. If it were possible to adopt the treatment generally indicated in psychoses of this nature, a cure could readily be effected by getting rid of the relatives and asking for advice from disinterested outsiders competent to express an opinion on university problems. Unfortunately, complications are apt to arise. Trustees, unaccustomed to the discussion of academic problems, will, when confronted by a crisis, feel the importance of immediate action. The faculty naturally resents what it considers to be an encroachment upon its prerogatives, and well-grounded serious misgivings as to the results that will probably follow the interference of laymen in the struggle for the establishment and maintenance of university ideals are sure to arise.

At present, trustees see things through a glass very darkly, as they themselves are generally strong partisans of institutions and lack not only a special knowledge of university problems, but are often deficient in a true sense of perspective. The choice of trustees in our eastern universities in a large number of instances is not determined by the individual's personal qualifications for the position, nor by his special knowledge of university problems. The selection depends frequently upon the partisanship of the candidate reflected in the uncritical attitude of devotion to his alma mater and a certain lack of discrimination, often a product of the hysterical domination of a phase of the college spirit which produces a hypo-sensitiveness in detecting the defects of his own and a corresponding degree of hyper-sensitiveness for picking out those of other institutions. This is one of the reasons why the information acquired by trustees from their friends in the faculty in regard to the relative value of work done in the different departments of the university often has about the same intrinsic worth when introduced as evidence as a Teutonic valuation of French scholarship, or a stand-patter's attitude towards the subject of tariff reform.

The trustees' lack of a clear understanding of the nature of university problems and their failure to cooperate with the faculty in the formulation of a definite policy for the development of the institution, is a very serious tactical error. The public, partly through ignorance, and partly through an instinctive feeling of distrust, caused by the silence of the administration as to the existence of any general plan for the development of the university, does not have any great degree of confidence that funds contributed are always expended to the best advantage.

A public statement of policy would avert another danger always imminent in the administration of university affairs. The acceptance of benefactions with attending conditions may be a curse and not a blessing. The American university has reached a stage in its development when it is no longer to be considered as a debtor to any public-minded, generous citizen who contributes to its financial support. The attitude passively assumed by trustees, that the policy determining the growth of the institution depends upon the sums of money contributed for maintenance, is not only

undignified, but it is in danger of becoming a thorn in the flesh.

This cringing form of mendicancy, always on the defensive, would cease to exist, if a carefully prepared plan for the future development of the institution was presented to the public. There is no reason why a great university should be apologetic in asking for financial support.

The sense of official obligation which often impels trustees to beg in a perfunctory manner for funds, making it possible to carry some plan or scheme into effect, the details of which are either unknown or are not carefully prepared for general scrutiny, does not generate sufficient strength of conviction among the representatives of the university to arouse by their appeals the interest of intelligent persons to the point when a favorable response may be expected.

Those institutions of learning which take the public into their confidence, at the same time pledging themselves to the maintenance of the highest academic ideals, will without doubt receive the necessary financial support. The resentful attitude sometimes adopted by an administration in the face of the well-directed criticisms from without, is often replaced by a singular indifference or apathy in formulating a working plan embodying any features suggested by those who are not intimately associated with the institution.

Several instances of this tendency to drift have recently occurred and may be taken as quite typical of what is unfortunately a frequent occurrence. One of the most distinguished scientists in the country offered in writing some suggestions for the development of departments along lines, which, if they had been followed, would have brought signal distinction and honor to a university with which he was not officially connected. The plan has never been discussed by either trustees or faculty, and it is only reasonable to suppose that the genuine interest in the affairs of this particular institution shown by an outsider, whose opinion is highly valued in university circles, has not increased if it has not altogether disappeared.

Very often prominent men are asked to state the conditions upon which they would go to certain universities. Their replies are sometimes given at length and are devoted to indicating the lines along which the work in certain departments should be directed. These replies, containing the valuable advice of experts, are seldom discussed by the faculty or trustees, and the possibility of making a successful public appeal for the carrying on of important work is not entertained. The effect of this lack of sympathetic, intelligent interest of the trustees in the actual progress of the university has become a serious drawback, and is quite as disastrous for the maintenance of high ideals as is the notion that it is possible to estimate the progress of an institution by the increase in the enrollments of students or by an enumeration of the list of new buildings.

The discussions that have occurred in academic circles during the past decade have served the double purpose of exposing defects inherent in the administration of most of our universities and have also been the means of suggesting the remedies. (1) There is a pretty general agreement that the autocratic powers of presidents and of all executive officers should be limited. In order to do this successfully, the conditions responsible for the present state of affairs should be modified. This would lead to setting reforms in motion, resulting eventually in an intelligent and active cooperation of the executives, trustees and faculty. An excellent plan has been suggested of limiting the tenure of office of

president and deans to a single period of four or five years. The salaries paid to executives should not greatly exceed that of the professors, nor should more elaborate provision be made for the residences of president and deans than for those of the faculty.

(2) Synchronous with the limitations imposed upon the authority of executives there should be corresponding and equally important changes in the board of trustees. A joint committee, as already suggested, consisting of three or five members from each board, viz., trustees and faculty, should act as the medium for keeping the former in touch and sympathy with the intellectual progress of the university. The presiding officer of this joint committee should be chosen by vote from either board and it would be well to limit his tenure of office to correspond with that of the president and deans. The reports of this committee would be quite free from the personal coloring given to the suggestions made by single executives. The establishment of a more intimate relationship would be reciprocally beneficial and would serve to give the faculty a greater sense of responsibility by introducing the discussion of questions of broader academic interest, and would lessen the tendency of individual members of the faculty to indulge in the petty recriminations and personalities which are the result of conditions arising from having lived too long in one place, and a limited intellectual horizon. A change of equally great importance would be the creation of an advisory board to trustees and faculty, composed of the members of the joint executive committee, to which should be added several representatives, preferably from the faculties of other universities. This enlarged committee should hold one or two meetings a year and from its foreign members a perspective view of the university could readily be obtained. The Princetonian should know how his alma mater appears when viewed from Cambridge, and the Harvard professor or overseer could sometimes correct a tendency to spiritual myopia by adopting suggestions coming from a source as distant from the Back Bay as is New Jersey. The tyrannical domination of certain forms of college spirit has become an obstacle to progress in the life of the older universities. Impatient of criticism and often expressing itself in the form of a flabby optimism it insists that the administration of the university should be directed solely by those alumni who possess "the requisite degree of knowledge of local conditions." The annual report of "outsiders" letting in fresh air from without the walls would in time lead the trustees to take a more intelligent appreciation of the intellectual life of the university.

The rate of development of our higher institutions of learning will be directly proportional to the rapidity with which trustees or regents familiarize themselves with the actual progress made in the university world. The majority of trustees on account of lack of knowledge have the tendency to look at university problems from the high-school or collegiate point of view. Their failure, in common with many other persons, to apprehend or appreciate the essential factors in the life of a great university at their proper valuation was referred to by the late President Gilman when he more than once affirmed that "the true university does not depend upon 'cloistered aisles' or a beautiful campus." He knew how often brains are sacrificed for buildings, and that institutions like individuals often built themselves wonderful tombs. If we except what has been accomplished in a few notable instances, there has been a general failure in our

eastern universities to comprehend the vital importance of encouraging productive scholarship. Business men as a rule have only a vague idea of the reasons for promoting and encouraging research and university trustees greatly need enlightenment on this subject. The mention of the word "investigation" suggests "mysteries," while research is looked upon in the light of a luxury carried on by professors as a pleasant relaxation from the ordinary drudgery of routine duties. This misconception of the spirit that dominates the investigator is a transmitted product of the times when the general public was satisfied to accept the first half of the definition of "university" given in the dictionary; namely, "an institution devoted to teaching."

Recently the reading public has reopened the dictionary and has found there is a second hitherto forgotten clause, "and to the higher branches of learning." Learning and teaching, if either one is to be successful, can not be disassociated. The investigator is a "learner" and teaching, if it is not to degenerate into dogmatism, a mere cramming of the memory with information, must be thoroughly inoculated with the spirit of youth. The instructor, who, in the ordinary sense of the word, is a teacher, an imparter of information, and one never having actually engaged in research, loses his mental plasticity at a much earlier age than the investigator. The spirit of eternal youth is the impetus and moving force of the great investigator. He is neither satisfied nor quiesced by the mere commands of authority. The apple falls from the tree, the pendulum swings in the cathedral, the blood leaves the heart, circulates through the body and returns to this organ, and his eyes are first to see these phenomena. He needs no "letter from the blind to those who can not see" to arouse his perceptive faculties. His sympathies are with the healthy child, whose interest in the universe has not been impaired by teachers competent only to impart information and constantly irritated by the "why" of irrepressible and impressionable youth. He does not discourage any attempt to look at the universe from Aristotelian or Platonic point of view, but admonishes the student to be himself rather than a mere pocket edition of the classics.

The basic principle underlying culture, expressed in the affirmation "no one is altogether right and no one altogether wrong," is the working creed of the investigator. His attitude of mind makes him instinctively reject as spurious the cultural specifics hawked in the market-place as cures for all the ills to which human flesh is heir. The invidious distinctions occasionally drawn by teachers, between those subjects which have a supposedly higher cultural value and those of more strictly utilitarian merit do not exist. The mental mechanism determining the individual possession of culture is merely an index of the functional capacity of the brain and nervous system. The factors upon which this mechanism depends are largely the product of racial and ancestral traits. Too much attention is frequently given to the infinitesimal influence of education in the supposed dissemination of these particular mental traits, while some educators are actually in danger of reducing the pursuit of culture to a fad. By proclaiming too vociferously the specific virtue of certain remedies, they not only expose the fallacies in the argument, but like the parvenu who continually harps upon the advantage of aristocracy, they make public confession of the absence in their own cases of the hereditary factors essential in the acquisition of culture. These same persons, says President R. S. Woodward, "having drunk deeply at

certain fountains of learning appear to be sure that there are no others." The spirit of investigation is a tonic, restoring vigor, self-reliance, and individuality to the members of the army of imitators that yearly receive degrees from our colleges and universities. It rebukes the artist whose chief ambition in life is to copy French models, ridicules the classicist who is only at his best when working in the Oxford atmosphere, or the scientist whose spectacles are made in Germany, and says to each of them, "Eyes have you and can not see, ears and hear not," and with the Persian poet is ready to exclaim, "I myself am Heaven and Hell." Instead of offering to the student an "a la carte" diet of selected facts and theories, it would teach him how to search intelligently for facts while cautioning him as did Bishop Berkeley to "consider the pains that have been taken to perplex the plainest things, that distrust of the senses, those doubts and scruples, those obstructions and refinements that occur in the very entrance of the sciences." If he remembers this admonition then "it will not seem strange that men of leisure and curiosity should lay themselves out in fruitless disquisitions without descending to the particular parts of life, or informing themselves in the more necessary and important parts of knowledge."

The university in which the spirit of research does not pervade the atmosphere bears a relation to the students similar to that of the nursery maids to the children playing on the beach, always within call of guardians, ever ready to emphasize the danger of young people venturing beyond their depth. The desire to enter deep water is more quickly aroused by watching expert swimmers than by reading dissertations on the art of swimming. Youth rebels at the needless restraints imposed by authority, and as an education is generally only the summons bidding it listen with becoming humility to the commands of the fathers, those in authority should recognize that the assumed indifferences of undergraduates to the claims of the intellectual world is often merely a protective form of reaction. Instead of repressing healthy instincts, why should not students be encouraged to believe that it is possible for them to advance the bounds of our present store of knowledge? The consciousness of leading in the procession always awakens stronger impulses and deeper interests than can be expected to develop in students who in all their mental excursions have been trained like the participants in the parade of a young ladies' boarding-school, to *submissively follow the teacher*.

The healthy, inspiring and contagious spirit of independence of the modern investigator, recalling that of the old Vikings with their uncontrollable desire to sail over unknown seas, should be fostered by our universities. The presence in these institutions of a large corps of investigators each led by a dominating interest in his special problems, is the sanest and safest method by which to combat "commercialism," create idealism and give undergraduates an intelligent appreciation of the pleasures of student life. "Words are feminine, deeds masculine," says the old Italian proverb. The patience of youth has been severely overtaxed by the length and number of the sermons to which it has been forced to listen. To-day the American university has a wonderful opportunity to teach by example. By making the encouragement of productive scholarship a primary and not a secondary duty students may be led to realize that an intelligent, normal interest in any subject is inseparably connected with the desire for progress.

The index of the healthy physical and

mental life of a great university is measured by the number and activities of its teachers and students who are actually engaged in productive scholarship.

During the period when trustees and regents have been more keenly interested than ever before in discussing the question as to whether the ideals of the high school and college should or should not dominate the policy of the university, two great foundations, the Carnegie and Rockefeller Institutions, have been dedicated to the advancement of learning. Gradually the real significance of their independent existences is becoming more and more apparent to those persons who are competent to form an opinion upon the nature and scope of university problems. The American university to-day is an institution devoted primarily to teaching, while its assumed right to the title of a seat of learning is still open to question. Will the old bottles hold the new wine? If they do not then the intelligent interest of a rapidly increasing number of American citizens, competent to distinguish the essential differences between collegiate and university ideals, will within a few years provide the means for the establishment of "higher institutions of learning."

Stewart Paton

Princeton, N. J.

PHYSIOLOGY AS A FUNDAMENTAL IN VETERINARY EDUCATION[1]

Education, like nature, should be orderly—a development from the simple to the complex. The development of the morphologically simple cell into the complex adult animal organism proceeds in an orderly way. The cell is the morphological unit and the mature animal consists of innumerable units, some of which have undergone a very great modification as to form. The cell can not be accepted as the physiological unit. What is apparently simple as to form is not necessarily simple as to function. The activities of the cell are but partially understood. The physiological unit, around which center these activities, is, like the atom of chemistry, invisible, but its power is unquestioned. Function is concealed in structure. Function is not often revealed without search and, indeed, research. In some instances it may be so superficial as to be easily recognized; in others it may lie so deeply that the keenest intellect is baffled in demonstrating its presence in a satisfactory manner.

The relation of physiology to the biological sciences is most intimate. It is not a question of independence but of interdependence. Many more or less plausible arguments may be advanced that one particular science may have a greater relative value than others. Chemistry and physics are concerned with matter and we ordinarily associate them with unorganized bodies. Physiology is restricted to *living* matter, or organized bodies. We can not consider inorganic material in physiological terms. Yet chemistry and physics are intricately involved in physiological processes and the question arises, perhaps, in the minds of some if, under the proper combination of conditions and of environment, life is not evolved from chemical reactions. Chemical action is constantly occurring in living tissue. Does it control the living tissue or does the living tissue control it? In the processes of filtration, diffusion and osmosis, physics occupies a relationship scarcely less intimate than chemistry. Solutions of crystallizable substances of unequal concentration separated by an animal mem-

[1] Presented at the meeting of the Association of Veterinary Faculties and Examining Boards of North America at Toronto, Canada, August, 1911.

brane will ultimately become uniform. Physics has demonstrated this. Is there any difference in the results if the animal membrane be living or dead? In some instances it has been shown that it does. Waymouth Reid introduced into the intestine of a living animal a certain amount of its own blood serum. The epithelial cells of the alimentary tract were therefore in contact on the one side with this blood serum and on the other with capillary vessels containing blood, the fluid of which had the same composition as the serum in the intestine. If the intestinal wall acted like an ordinary dead membrane there could be no passage of the serum from the intestine to the blood by diffusion or osmosis. It was found that the serum was rapidly absorbed. This could not be due to ordinary filtration because the pressure in the intestine was less than in the capillaries. The conclusion was reached that while known physical forces play a certain part in absorption, there remains an unexplained factor. Some, however, regard this unexplained factor as the living cell and that because of its living condition two separated fluids of uniform composition were made to unite against pressure.

A somewhat similar example occurring in the kidney may be referred to. Urine contains a much higher percentage of urea than does the blood, but in spite of that the extremely weak solution of the urea in the blood gives up its urea to the more concentrated solution in the urine. Physical law will permit the passage of a substance from the stronger to the weaker solution, but not the reverse.

Cooperation is the key-note of physiology. In no other science, perhaps, do we have such striking examples. Since the time of Sir Charles Bell, physiologists have recognized the importance of the nervous system in coordinating and regulating the various bodily functions. In comparatively recent years the realization has grown that the harmonious adjustment of the various tissues is not confined entirely to the numerous reflexes through the nervous system, but that there is in addition a regulation by chemical means through the blood and other fluids of the body. The development of our knowledge of the internal secretions led Brown-Sequard to the generalization that every tissue in the body in the course of its normal function gave material to the blood which was of use in regulating the activity of other tissues. This idea has been supported by facts brought out in connection with the study of the ductless glands of the body. The generalization of Brown-Sequard has been confirmed in a definite way by the investigations of Bayliss and Starling upon secretin. They have demonstrated that when hydrochloric acid is brought in contact with the epithelial cells of the duodenum a substance (secretin) is produced which passes into the blood and is carried to the pancreas and stimulates it to secrete the pancreatic juice. This is a definite example of a substance which, originating in one tissue, is of direct aid in the function of another tissue in a chemical way. Such a substance has been designated by Starling as a "hormone."

The epithelial cells of the duodenum cooperate in still another very striking manner. When the pancreatic juice is secreted its proteolytic enzyme is in the form of trypsinogen—an inert substance. As soon as it comes in contact with the duodenum, the trypsinogen is activated or converted into trypsin, which has the power of acting vigorously upon proteid material. The substance which causes this activation is known as enterokinase. It would thus appear that the duodenal cells are doubly cooperative in assisting other tissues in a

chemical way. The secretin which they produce is comparable to an internal secretion, since it is turned into the blood and stimulates the pancreas to perform its function; the enterokinase, on the other hand, is comparable to an external secretion since it is turned into the intestinal cavity and thereby activates one of the important constituents of the pancreatic secretion.

An interesting cooperative cycle is apparently established around the duodenum. In the stomach, pepsinogen is secreted by certain cells in the gastric glands; this presumably is activated to pepsin by the hydrochloric acid formed by another type of cell in the gastric glands. The gastric chyme with its hydrochloric acid, on reaching the duodenum, stimulates the production of secretin, which in turn stimulates the flow of the pancreatic juice. The pancreatic secretion on reaching the duodenum induces the production of enterokinase by which its trypsinogen is activated to trypsin.

Because of the considerable amount of carbohydrate in the diet, it might naturally be expected to find a vigorous diastatic enzyme in the saliva of the horse, if in any animal. Yet the saliva taken from the duct of the parotid gland is unable to convert a starch mixture into a reducing sugar except to a very limited extent and after a considerable period of time. Is there an absence of the diastatic enzyme, except such as may filter through to the secretion from the blood, or is there an inert ptyalinogen which meets its activator further down the tract and is there converted into the active ptyalin?

Other examples of cooperation may be mentioned in connection with the pituitary body of the brain, and the thyroid and suprarenal glands. Although not provided with ducts, an internal secretion is nevertheless formed which is turned into the blood and lymph and exerts an influence upon the other tissues of the body so important that if the glands become diseased or removed, serious or fatal consequences result.

One of the most interesting examples of an internal secretion which is not necessary to life but which yet profoundly affects the chemical changes occurring in the body is that of the ovaries. It has long been familiar to stockmen and others that the removal of the ovaries increases considerably the rapidity with which fat is laid on. According to the researches of Loewy and Richter of Berlin the explanation is that the ovaries produce a substance which hastens the oxidation of the tissues and the food. When this substance is injected under the skin of animals in which the ovaries have been removed, the tissue waste is markedly increased.

Since physiology is concerned with living matter and that alone, the border lines between it and other biological sciences must of necessity be indefinite and more or less overlapping. This is peculiarly true as to its relation with pathology, medicine and therapeutics. The chief function of the living tissues is change—metabolism. Changes of composition, form or even structure are pertinent to physiology if they occur in the living tissue. The activity of the tissues may be increased or decreased for a greater or less time and the conditions still remain within normal limits. There may be a lack of cooperation for a time without abnormal results. The dividing line between the normal and the abnormal is at the outset imperceptible. Bacteria are present in the normal body and are more or less concerned with the normal functions of the alimentary tract.

Physiology stands for cooperation, pathology deals with a disturbed coopera-

tion. A tissue unduly excited will, in time, disturb the harmonious adjustment of certain other tissues producing a chain of results which induces an abnormal or pathological effect upon the organism, as a whole, and medical science is invoked to alleviate the disturbed condition and to restore the normal adjustment. In other instances the hyperexcitability may be localized in a given tissue, as with a benignant tumor without apparent interference with the normal functions of the other parts. Pathology is physiology gone wrong and, although it has been emphasized before, it is well to emphasize it again: that to understand the abnormal, it is necessary to have as complete a knowledge as possible of the normal organism.

If it is the province of pathology to point out the differences between the normal and abnormal, it is the very important duty of medical science to attempt the restoration of the abnormal to the normal. If it is important for the surgeon to know thoroughly the form and structure of the tissues in order that abnormal or diseased parts may be removed with the hope of bringing about a normal condition again; then is it equally important for the medical practitioner to know thoroughly the functions of the tissues and their system of cooperation, if he is to restore the diseased organism to its normal physiological standard. Therapeutics must be invoked with a knowledge of those agents which will stimulate the weakened parts to their normal tone, or which will soothe the overirritable or overexcited tissues to their natural calm. Without anatomy we may assume there could not be proper surgical procedure; we may equally assume that without physiology there could not be satisfactory medical practise. Indeed, the practitioner's service is but an extended laboratory course in physiology.

Diseases are due to a disturbance of physiological cooperation either internally through the interrelationship of the different tissues or externally from the introduction of material foreign to the organism. In veterinary practise there is perhaps no more striking example of disturbed cooperation than in azoturia. Why should renewed work after a day or two of idleness cause such a physiological upheaval in the horse as to make it necessary to record so large a percentage of fatalities? The answer will probably be found in the disturbed adjustment of the circulation, muscular and renal tissues, caused, perhaps, through chemical substances introduced through the digestive system and influenced more or less by external conditions. Why are other domesticated animals exempt from this affection? The hydrocephalic dummy, parturient paresis in cattle, and many other diseases when finally worked out may be found to be due to the production of some chemical substance developed in one tissue, which, circulating to other tissues, excites them directly or reflexly to such an extent that the whole adjustment is thrown into more or less disorder.

In the urine of man, more than a trace of indican is pathological. Why should the relatively large amount of this substance usually found in the urine of the horse be regarded as a normal condition?

In order to solve the problems of the normal as well as the abnormal, it would appear essential to work out the physiology of each species of the domesticated animal distinctly. While many of the conditions may be fundamental to all, there are some characters which are peculiar to each type. Physiology is not all internal; external conditions must be reckoned with. Diet, habit and environment all contribute to

the harmonious adjustment of the internal mechanism.

The practitioner should not be blamed too severely for a certain amount of empiricism. Physiology has not yet solved all of its problems and until the solution is forthcoming a strictly rational treatment of all diseases is impossible.

If my meaning has been clearly expressed, it should be apparent that physiology is a *living* science and is concerned with the manifestations of life; its action is cooperative, not only to the tissues in an individual organism, but in a broader sense to the other biological sciences; it is fundamental especially to pathology and medicine, and, cooperating with them, seeks to conserve the general health of animals and man.

PIERRE A. FISH

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ADDITIONAL FACTS ABOUT THE CHESTNUT BLIGHT

THROUGH a desire to be as concise as possible, the early history of the chestnut blight investigation in Pennsylvania was not given in my recent account in SCIENCE. As there seems to be a demand for the facts, the following is submitted:

On June 13, 1908, Professor John W. Harshberger received a letter from Mr. Harold Peirce, of Haverford, asking if the University of Pennsylvania could detail a man to investigate the work of a borer, or of a fungus, on the chestnut trees in his woodland at Haverford. Under date of June 18, 1908, Mr. Peirce arranged for Professor Harshberger to inspect his trees with a view to discovering the cause of their disease. As a result of the microscopic study, it was found that the trees were attacked by the chestnut blight fungus recently described by Dr. Murrill, of New York. Thus Mr. Peirce became deeply interested and called together a number of public-spirited citizens. Several public meetings were held at which Professor John Mickleborough and Professor Harshberger gave an account of the life history of the fungus and what might be done to stay the advance of the blight. Subsequently, at the suggestion of Professor Harshberger, a committee of the Main Line Citizens' Association requested the Pennsylvania Department of Forestry to assist in inspecting the chestnut trees in the neighborhood of Bryn Mawr and Haverford. On May 3, 1910, a meeting was held at the house of Mr. Robert W. Lesley, at which meeting, in response to their request, the Deputy Commissioner of Forestry (the undersigned) met with the committee and formulated the chestnut blight campaign. As a result of the agitation, the committee of the Main Line Citizens' Association, consisting of Messrs. Harold Peirce (Chairman), Theodore N. Ely, Allan Evans, Edgar C. Felton, William Righter Fisher, Alba B. Johnson and Robert W. Lesley, under date of August 1, 1910, issued an appeal to the property holders of their neighborhood for money to make a preliminary inspection.

The response was a generous one, so that the committee secured the assistance of Mr. George H. Wirt, state forest inspector, and a force of student foresters from the State Forest Academy at Mont Alto, under the direction of the writer, while Professor John W. Harshberger, of the Botanical Department of the University, agreed to assist as fungolist and botanist. Mr. Clarence R. Cornman, of Gladwyne, represented the committee in the active field work, while Mr. Oglesby Paul also aided the committee with counsel and advice.

On September 1, 1910, the inspectors from Mont Alto arrived and headquarters were opened in the Merion Title & Trust Company Building in Ardmore. As the work of inspection proceeded the Main Line Citizens' Committee realized that the work had assumed a national scope. At the suggestion of Professor Harshberger, the United States Department of Agriculture was requested to cooperate and a favorable reply to that request was received on November 1, 1910, from Dr. Haven Metcalf, in charge of the office of forest pathology, Bureau of Plant Industry.

Since that date, Dr. Metcalf has actively cooperated. Two experts have been detailed by him to assist in the work in Pennsylvania, viz: Professor J. Franklin Collins and Professor Ernest Shaw Reynolds. The appropriation of $5,000 by congress, secured through the efforts of Senator Boies Penrose, and the large appropriation of $275,000 by the state of Pennsylvania, have been mentioned in the preceding account in SCIENCE. Since the Chestnut Blight Commission was organized, Professor J. Franklin Collins has been in charge of an instruction camp in Lancaster County, where the scouts are trained and a scientific investigation of the disease has been begun by a special collaborator of the United States Department of Agriculture, Dr. Caroline Rumbold.

Through the active interest of Provost Charles C. Harrison and his successor, Provost Edgar F. Smith, the University of Pennsylvania, in November, 1910, placed at the disposal of the commission the apparatus of the botanical department of the university, of which Professor John M. MacFarlane is the head. During the past summer and early fall, Dr. Rumbold has been conducting a series of cultures and experiments of the most important nature.

The public-spirited action of the authorities of the University of Pennsylvania is especially deserving of commendation. Those interested in this work look with confidence to the university to make known new facts of lasting value.

I. C. WILLIAMS

THE SARAH BERLINER FELLOWSHIP

THE donor of the Sarah Berliner Fund, Mr. Emile Berliner, of Washington, has taken so much satisfaction in the work done by the holders of the fellowship which it supports that he has now doubled the original endowment, and the fellowship will hereafter be awarded every year, instead of every other year. Applications for this fellowship should be in the hands of the chairman of the committee, Mrs. Christine Ladd Franklin, 527 Cathedral Parkway, New York, by the first of January of each year; they should contain (1) testimonials as to the value of work already done, (2) copies of published contributions, or other accounts of investigations already carried out, (3) evidence of thoroughly good health, (4) detailed plans for the proposed use of the fellowship. Applicants must already hold the degree of doctor of philosophy, or be similarly equipped for the work of further research. The value of the fellowship is one thousand dollars, and it is available for study and research in physics, chemistry and biology (including psychology), in either Europe or America.

The directors of the foundation, besides the chairman, are: President M. Carey Thomas, Bryn Mawr College; Miss Laura Drake Gill, president of the Association of Collegiate Alumnæ, Boston; President Ira Remsen, Johns Hopkins University, and Professor William H. Howell, of the Johns Hopkins Medical School.

This is one of the two largest endowed fellowships offered to women in the United States. The donor of the fund, Mr. Berliner, is well known as one of the perfecters of the telephone and the inventor of the gramophone. It is named in honor of the donor's mother, who was a woman of remarkable force of character.

Most fellowships accessible to women—and, in fact, the same thing is true of fellowships for men—are given to recent graduates of colleges, to enable them to proceed towards the degree of doctor of philosophy. The object of this endowment, on the other hand, is to give to women who have shown, in work already accomplished, promise as investigators an opportunity to pursue special scientific researches—and, in particular, to tide them over the period between the time when they deserve to hold a good instructor's position in some college and the time when they succeed in obtaining it. Many doctors of philosophy are forced to go into teaching in the preparatory schools, and they thus lose in exhausting work the very years when they are best fitted to be original investigators—as has been forcibly pointed out by Professor Woodworth in a

recent article in SCIENCE. There is no way in which the endowment of research can be more successfully carried out than by saving for a scientific career those students who have already shown distinguished capacity for work. Not to save them, when they are already an expensive as well as a rare product, is a lamentable piece of wastefulness. The Sarah Berliner Fellowship Fund is therefore calculated to do more certain and more effective good than many a larger endowment.

C. L. F.

NEW YORK,
November 3, 1911

A FIELD SCHOOL OF GEOLOGY

DURING the month of September a party of eleven advanced students from the Department of Geology of the University of Chicago undertook a careful examination and geologic survey of a portion of the Montrose Quadrangle of southwestern Colorado. The work was done under the direction of Dr. Wallace W. Atwood, and was the opening season of the Field School of Geology which has been established in connection with the advanced work in geology at the University of Chicago.

The headquarters during the season was Ouray, Colorado. The party lived in camp, and the work was conducted as nearly as was practicable in conformity with the requirements of the National Survey. The area selected for work was west of the Ouray Quadrangle and north of the Telluride Quadrangle. It was at the north side of the San Juan Mountains where a large variety of formations and of structural and stratigraphic problems was presented.

During the first few days the party worked as a single group, visiting typical exposures of the formations as they had been mapped in the adjoining quadrangles, in an excursion into the interior of the range for an appreciation of the mountain mass adjoining the area to be surveyed and in an examination of certain of the more accessible mines and mills in the vicinity of Ouray. At the close of this introductory work the party was broken up into "teams" of two or three each, and each "team" was given a separate portion of the unmapped area for which that "team" was held responsible. When the work accessible to one camp had been completed, the camp was moved into the adjoining area and the new territory divided among the various "teams." Special care was given in the redistribution of work that the men received as wide a range of experience in field work as was possible. During the four weeks the party surveyed with care about 160 square miles, and had opportunity of examining a somewhat larger area. The problems met with involved many in stratigraphy, some in faulting, folding, intrusion, extrusion, glaciation and a complex erosion history. The region selected was one of great scenic beauty and of diverse human interests, so that the season in camp was a most pleasant and agreeable one. The average expense for the student, including the tuition at the university and all traveling and camp expenses, was $150. The University of Chicago has purchased a camp outfit and it is proposed that the work of this Field School of Geology be continued in Colorado for a number of seasons. It may then be moved to some other region where there is an unsurveyed field that presents a wide range of geologic phenomena.

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

THE work of the survey, during the season just closed, has been carried on in three divisions.

I. *Geology*.—State Geologist W. O. Hotchkiss, has been in charge of a party of six men, completing the field work begun in 1910 on the Florence Iron District. This district is the western extension of the Menominee Iron Range of Michigan and connects that range with other districts to the northwest. Its geology has long been a puzzle to geologists, as well as to those interested in mining, and the results of the survey are awaited with much interest. The territory has been very carefully studied and the survey will show a considerable area in which it will be worth while to prospect for iron ore.

The state geologist was instrumental in securing the establishment by the last legislature of a State Highway Commission, of which he is *ex-officio* a member. He has given much time to the work of the commission, which is preparing plans for expending annually on road improvements a million and a quarter dollars.

The field work of Dr. Samuel Weidman in areal geology in northwestern Wisconsin was mainly confined to the study of the glacial geology. The moraines of the older drift sheets were traced out and the relation of these moraines to the alluvial deposits studied in detail. Besides the glacial geology, the structural features of the Paleozoic, the Potsdam, Lower Magnesian, St. Peter and Trenton formations were also special problems of investigation.

II. *Natural History.*—This division, under Director Birge and Mr. Juday, has given most of its time to beginning a series of careful quantitative chemical and biological studies on the plankton of Lake Mendota. During two weeks a party of eight were engaged in investigating the oscillations of the lower water of Green Lake as indicated by the temperature. Some 5,000 temperature readings were taken, which show regular oscillations of the water following strong winds. The survey installed in April a Callendar sunshine receiver and recorder for registering the vertical component of sun and sky radiation, and series of temperatures have been taken twice a day, in Lake Mendota, so as to correlate the gains and losses of heat in the lake with the heat received from the sky. In all of this work the survey has been assisted by the U. S. Bureau of Fisheries and the Wisconsin Fish Commission. Through an appropriation made by the latter body, Mr. J. N. Loshinski was enabled to devote a month to making additions to the survey's collection of Wisconsin fishes. He gave special attention to securing specimens of local species and varieties of whitefish.

III. *Soils.*—The Soil Survey has been continued in cooperation with the Agricultural College, under the direction of Professor A. R. Whitson. The survey is also cooperating with the Bureau of Soils of the U. S. Department of Agriculture. During the summer the detailed field work of Fond du Lac, Kewaunee and Juneau Counties has been completed and is well under way in Columbia and Buffalo counties. The reconnaissance work in the northwestern part of the state is being continued and has now covered practically all of Bayfield and Douglas counties and a large part of Washburn and Burnett. The great value of this work, as preliminary to the extension and investigational work being carried on by the Agricultural College and Experiment Station, is becoming more and more obvious as the work progresses.

IV. *Publications.*—During the year the survey has issued a bulletin (No. XXI.) on the fossils and stratigraphy of the Middle Devonic, by H. F. Cleland; one (No. XXII.) on the dissolved gases of the lakes, by E. A. Birge and C. Juday; and one (No. XXIII.) on the soils of the northwestern area, by S. Weidman. The U. S. Department of Agriculture has also issued reports of a joint soil survey of Marinette County, by S. Weidman and P. O. Wood, and of Waushara County, by J. W. Nelson and G. Conrey. State editions of these bulletins will soon appear.

There is in press a general geological and road map of the state, by W. O. Hotchkiss and F. T. Thwaites, besides several reports on soils.

Two reports are nearly ready for the press: one on the Peat of Wisconsin, by F. W. Huels; and one on the Lake Superior Sandstone, by F. T. Thwaites.

THE WILL OF MR. JOSEPH PULITZER

BY the will of Mr. Joseph Pulitzer, the gift of a million dollars to Columbia University to establish a school of journalism is confirmed. A second million dollars is to be paid to the university for the school of journalism and for prizes which it is instructed to award, if within seven years of his death the school shall in the opinion of his executors have been in successful operation for three years. In the meanwhile the income is to be paid to Barnard College for scholarships in memory of his daughter unless the deaths should have

occurred of the presidents of Columbia and Harvard Universities. In case Columbia University does not fulfil the conditions the bequest will go to Harvard University. Mr. Pulitzer has also bequeathed $500,000 to the Metropolitan Museum of Art and $500,000 to the Philharmonic Society. The income from the New York *World* and the St. Louis *Post-Dispatch* is to be divided in tenths, six tenths to be paid to his youngest son, who is now fifteen years of age, two tenths to his second son and one tenth to his oldest son, one tenth to be held for the benefit of the editors and managers of the newspapers. The income of the youngest son is, however, restricted to $40,000 a year between the age of twenty-one and twenty-five and $60,000 a year between the age of twenty-five and thirty. The income of the second son is restricted to $60,000 a year. These incomes are to be doubled in case of the marriage of the sons. The balance, which may be very large, as the estimated value of the journals is twelve million dollars, is to be paid to Columbia University, the Metropolitan Museum of Art and the Philharmonic Society, subject to certain conditions which are not stated. Mr. Pulitzer also bequeathed $250,000 to Columbia University for scholarships for young men educated in the public schools of the city of New York.

SCIENTIFIC NOTES AND NEWS

THE following awards have been made by the president and council of the Royal Society: a Royal medal to Professor George Chrystal, Edinburgh, whose death has meanwhile occurred, for his researches in mathematics and physics, especially his recent work on seiches and free oscillations in the Scottish lakes; a Royal medal to Dr. W. M. Bayliss, F.R.S., for his researches in physiology; the Copley medal to Sir George H. Darwin, K.C.B., F.R.S., for his scientific researches, especially in the domain of astronomical evolution; the Davy medal to Professor Henry E. Armstrong, F.R.S., for his contributions to chemical science; the Hughes medal to Mr. C. T. R. Wilson, F.R.S., for his investigations on the formation of cloud and their application to the study of electrical ions.

IT is now reported from Stockholm that Professor W. Wien, professor of physics in the University of Würzburg, is to receive the Nobel prize for physics.

SIR WILLIAM H. WHITE, former chief constructor of the British Navy, has received the John Fritz medal for notable achievement in naval architecture.

IN honor of Professor Wilhelm Waldeyer, the eminent anatomist, who recently celebrated his seventy-fifth birthday, a tablet has been placed on the house in which he lived while a student at Göttingen.

MR. WILLIAM HOBSON, professor of mathematics at the University of Cambridge, has been elected a member of the Halle Academy of Sciences.

THE Royal Geological Society of Cornwall at its annual meeting on October 31 presented the Bolitho gold medal to Mr. Clement Reid, F.R.S., in recognition of his work on the geological resurvey of the county.

PRESIDENT DAVID STARR JORDAN, of Stanford University, has returned to California from a visit to Japan made in the interest of the World Peace Foundation, of which he is head director. President Jordan expects to spend a part of the winter in Boston. He is on leave of absence from Stanford during this semester; in his absence Dr. John C. Branner, professor of geology, is acting president of the university.

THE Australian government is about to undertake measures for the settlement of the Northern Territory, and during the present year has sent several parties to make preliminary investigations in that region. The leadership of one party was entrusted to Professor Baldwin Spencer. They went to Port Darwin, and from there across to Melville Island; then they returned to Port Darwin and traveled south about two hundred miles, after which they crossed the continent to the Gulf of Carpentaria.

Dr. Gustav Förster has been appointed observer at the Geodetic Institute at Pottsdam.

A food and drug laboratory has been organized in connection with the department of chemistry at the Montana State College, at Bozeman. Provisions for equipment and maintenance were made in the pure food law passed by the last Montana legislature. The organization of the laboratory staff is as follows: W. M. Cobleigh, state chemist; C. E. Millet, director of drug analyses; Drury L. Weatherhead, food analyst; D. B. Swingle, bacteriologist.

The seven hundredth meeting of the Philosophical Society of Washington will be held at the Cosmos Club on Saturday evening, November 25, 1911, at 8:30 o'clock, when the address of the retiring president, Dr. Arthur L. Day, will be given on "Geophysical Research."

President Charles R. Van Hise, of the University of Wisconsin, delivered four lectures at the Lowell Institute of Boston last week, the first on "Some Aspects of Conservation," on November 15. He also spoke at Harvard University on "Concentration in Industry."

Dr. Heinrich Ries, professor of economic geology in Cornell University, gave an illustrated lecture on the "Mineral Resources of Western Canada" to the students of geology and engineering at the University of Virginia, on November 1.

The fifth lecture of the series before the Harvey Society will be delivered by Professor W. T. Sedgwick, of the Massachusetts Institute of Technology, on Saturday, November 25, at 8.30 P.M., at the New York Academy of Medicine, 17 West 43d Street. The subject is: "Illuminating Gas and the Public Health."

Mr. John Brown, F.R.S., who retired from business in 1882 to engage in scientific work, died on November 1, at sixty-one years of age.

Dr. Max Jaffe, professor of pharmacology at the University of Königsberg, has died at the age of seventy years.

The death is announced of M. E. F. André, for many years editor of *La Revue Horticole* and the author of works on landscape gardening.

The American Society of Naturalists will hold its twenty-ninth annual meeting at Princeton University on Thursday, December 28. At the morning session a series of invited papers will be presented on The Relation of the Modern Study of Genetics to the Problems of Evolution. These papers will be followed by an open discussion. Special papers on studies in evolution and heredity have been invited for the afternoon session. On Thursday evening the naturalists will give their annual dinner at which the president, Professor H. S. Jennings, will deliver his address.

The Eastern and Central Branches of the American Society of Zoologists will hold a joint meeting at Princeton University, Princeton, N. J., during Convocation Week, December, 1911, in connection with the meeting of the American Society of Naturalists and the Association of American Anatomists. A preliminary program will be mailed to members of the American Society of Zoologists about December 10, 1911. Members expecting to present papers at this meeting should send the titles to Professor Raymond Pearl, Orono, Maine.

The New York State Teachers' Association and affiliated societies will meet at Albany on November 27, 28 and 29. One of the associations is the Science Teachers' Association, of which Mr. L. S. Hawkins, of the Potsdam Normal School, is president. The sections and their chairmen are as follows: *Physics and Chemistry*—H. A. Carpenter, West High School, Rochester. *Biology*—G. A. Bailey, Geneseo Normal School. *Earth Science*—J. H. Cook, Albany High School. *Agriculture*—H. Sibley, Rochester.

As in previous years, the Museum of Vertebrate Zoology of the University of California was active during the past spring and summer in carrying on zoological field work. This year the work was conducted entirely within the state of California, in accordance with the principle that a knowledge of the native fauna is of first importance to a state institution of

this kind. The three months from March to May, inclusive, were occupied in exploration of the San Joaquin Valley along its entire length, the particular purpose being to ascertain the status of the rodent population of the region. The ranges of the native members of the squirrel family were determined with some accuracy, this information having definite bearing upon the problems to be met by the federal and state authorities who are dealing with the plague situation. Much material in the way of specimens and information was gathered. This work was prosecuted by Mr. Swarth and Mr. Grinnell, with two assistants. Miss Annie M. Alexander and Miss Louise Kellogg with two assistants spent the three summer months in the high mountain region of Siskiyou and Trinity counties, collecting birds and mammals, in continuance of work begun by them during the previous winter. The series of specimens gathered includes several species new to the museum and one bird new to the known fauna of the state, while much information bearing upon the relationships of the Shasta and coast faunas was obtained. The period from June 15 to September 15 was occupied in exploration of the mountainous region lying between Tehachapi and Mount Whitney. Mr. Grinnell, Mr. Taylor and three assistants were engaged in this work, the results comprising, aside from large series of specimens of mammals, birds and reptiles, an increased knowledge of the complex faunal conditions at the southern end of the Sierra Nevada. All of the above field work was made possible through special gifts by Miss Alexander of funds for its support.

THE British Decimal Association, established to promote the adoption of a decimal system of weights, measures and coinage in the United Kingdom, announces that a weights and measures law, rendering the use of the metric system compulsory in Bosnia-Herzegovina, will come into force on September 1, 1912.

THE Smithsonian party which accompanied Dr. A. O. Wheeler, president of the Alpine Club of Canada, on his topographic survey of the British Columbia and Alberta boundary line and the Mount Robson region, has returned to Washington. The party was a small one, consisting of four members including Mr. N. Hollister, assistant curator of mammals, and Mr. J. H. Riley, of the division of birds in the National Museum. Assembling at Edmonston, Alberta, Canada, early in July, the party proceeded on the Grand Trunk Railroad to the end of the line, where they took pack horses to penetrate the Mount Robson region. The land to be surveyed included the territory lying about this mountain, probably between 14,500 and 15,000 feet high, and surrounding it for a distance of fifty miles. The natural history work was divided up, Mr. Hollister and Mr. Riley collecting the birds and small animals, while the other two collectors hunted big game. The collection includes some 900 specimens of birds and mammals. Much material for exhibition groups was secured, including a series of caribou, mountain goats, mountain sheep, beavers and many varieties of smaller animals. Besides birds and mammals, large numbers of plants and insects were collected. All the specimens have been turned over to the National Museum and when the collection is worked up, parts of it will be put on exhibition.

MR. F. W. HODGE, ethnologist in charge of the Bureau of American Ethnology of the Smithsonian Institution, has returned to Washington from an expedition to New Mexico, conducted under the joint auspices of the bureau and the School of American Archeology at Santa Fe. Early in September Mr. Hodge proceeded to El Morro, or Inscription Rock, in western New Mexico, where, with the assistance of Mr. Jesse L. Nusbaum, of the School of American Archeology, paper impressions and photographs of the inscriptions on the rock were made. Mr. Hodge later joined Dr. Edgar L. Hewett, director of the School of American Archeology, on an expedition to the Jemez Valley, about sixty-five miles northwest of Albuquerque, where excavations were conducted in the ruins of a large stone pueblo known as Amoxiumqua, which measures about 1,100 feet by 600 feet, and is situ-

ated on a mesa rising 1,800 feet above Jemez River.

The United States produced 255,534 long tons of sulphur in 1910, valued at $4,605,112, according to figures compiled by Mr. W. C. Phalen, of the U. S. Geological Survey, and published as an advance chapter from "Mineral Resources." This is an increase of 16,222 tons in quantity and $173,046 in value over the output for 1909. The sulphur industry in this country is substantially an American one, for the imports for 1910 were valued at only $558,611, while the exports amounted to $552,941. Four states—Louisiana, Nevada, Utah and Wyoming—produced practically all of our sulphur. Mr. Phalen discussed the geologic occurrence and technology of sulphur in the 1909 chapter of "Mineral Resources." In the chapter for 1910 he gives a detailed account of the important foreign sulphur deposits—those of Italy, Japan and other countries. The report also contains the statistics of production of pyrite in the United States, which in 1910 amounted to 238,154 long tons, valued at $958,608. The imports of this mineral were largely in excess of the domestic production, being 803,551 long tons in 1910, valued at $2,748,647.

A Manual of Philippine Silk Culture by Charles S. Banks, recently published by the Bureau of Science of the Government of the Philippine Islands, Manila, is based upon six years experimental work with the mulberry and other races of silkworms. The mulberry silkworm, a normally monovoltine species, has been caused to produce 8 to 9 generations a year of healthy, robust caterpillars from a stock imported from Ceylon where it had normally produced 6 to 7 generations. Hybridization of Bengal-Ceylon polyvoltine silkworms which produce yellow cocoons and Japanese monovoltine silkworms which produce white ones, resulted in the Philippines, in 2 races of silkworms producing white polyvoltine cocoons. One industrial school located at Batac, Ilocos Norte, has already taken up silk culture with its Filipino students with excellent success, and it is planned to start other centers throughout the Islands. At present there is no commercial production of silk in the Philippines, but Mr. Banks's work demonstrates that a large new industry is feasible. The manual contains minute directions covering the care and propagation of both mulberry and eri silkworms, diagrams of houses and reels and is copiously illustrated.

It is stated in the *Journal* of the American Medical Association that a Pasteur Institute has just been established at Algiers, the technical and administrative direction of which is undertaken by the Pasteur Institute of Paris. This direction has been entrusted to Dr. Chalmette. The scientific make-up of the new institute comprises a service for rabies, a service of bacteriology applied to medicine, an antimalarial service, a service of agricultural microbiology and a veterinary service. The site on which the new buildings are being constructed covers an area of about 2½ acres, in one of the most beautiful spots in the suburbs of Algiers. The architecture of all the buildings is of the simplest, without any costly decoration, and the details of the interior arrangement have been carefully studied so that the expense of the undertaking may be reduced to a minimum, and also with an eye to furnishing all the desirable conveniences for future workers in the laboratories. Thoroughly equipped laboratories are close at hand to each service. Daylight is plentiful everywhere, and the grouping of the laboratories on the northeast side of the building prevents the sunlight from being an annoyance in the microscopic work. One interesting detail is that all the outside openings are covered with brass wire netting, and each door is protected on the inside by a screened vestibule, so as to make it impossible for any fly or mosquito or other winged insect to get inside.

The mineral tungsten (the name meaning heavy stone) has been known for many years, but only comparatively recently has it become of economic importance. The most important use, according to Frank L. Hess, of the United States Geological Survey, and the

one which makes tungsten mining on an extensive scale possible, is an alloy for tool steel. Lathes using tools made from tungsten steel may be speeded up until the chips leaving the tool are so hot that they turn blue, an operation which would ruin the temper of high-carbon steel. It is stated that about five times as much can be done with lathes built for such speed and work as can be done by the same lathes with carbon-steel tools. From 16 to 20 per cent. of tungsten is ordinarily used in lathe tools. The melting point of tungsten is exceedingly high—5,576° F. Tungsten also has an important use in making incandescent electric lamps, crucibles for electric furnaces and various other articles.

To bring the farmers of Maryland and the people of the metropolis of Maryland into closer moral and business touch, and with a view to the better education of the agriculturalists in scientific methods of crop raising, and the care and selling of crops, a mammoth State Exposition will be held in Baltimore from December 4 to 9 under the auspices of the Maryland Horticultural Society, and allied farmers' organizations, including the Maryland State Grange, Cereal and Forage Crop Breeders' Association, Maryland State Dairymen's Association and Maryland Bee-keepers' Association. It is called the Maryland Week Exposition, and is the outgrowth of a suggestion made by the Baltimore *Sun*. The exhibit of Maryland's products will fill the hall of the Fifth Regiment Armory and it will be the most comprehensive exhibit of Maryland's soil and general farm products ever held in the state. Each day there will be meetings in sections of the various associations, and every day at 2 o'clock there will be a general meeting of the affiliated bodies to hear lectures by distinguished exponents of practical farming. Among the speakers engaged for the week are James Wilson, secretary of agriculture, and W. M. Hays, assistant secretary of agriculture; Willis L. Moore, chief of the United States Weather Bureau; Professor H. A. Waugh, head of the division of horticulture of the Massachusetts Agricultural College; H. A. Huston, former director of the Indiana Experiment Station; Governor Woodrow Wilson, of New Jersey; Governor A. L. Crothers, of Maryland; R. L. Watts, of the Pennsylvania State College; J. H. Hale, of Connecticut, whose peach orchards are the largest in the world, and R. A. Pearson, commissioner of agriculture of New York state.

The National Association for the Study and Education of Exceptional Children will hold its second annual conference on the problem of the exceptional child on Friday and Saturday, December first and second. The day sessions will be held in the auditorium of the School of Pedagogy of New York University, Washington Square; and there will be an evening session on Friday in the building of the Society for Ethical Culture, Central Park West, New York City. A number of educators, physicians and social workers will participate in the proceedings and read papers. The topics to be discussed are as follows: First, "Causes of Exceptional Development in Children"; second, "Educational Needs of the Various Kinds of Exceptional Children"; third, "The Exceptional Child as a Social Problem."

In response to the appeal to raise the sum of £15,000 as a building fund for the Galton Laboratory for National Eugenics at the University of London, sums amounting to a total of £2,260 have been given, promised, or promised conditionally on the buildings being begun within two years. The subscriptions include: Mr. W. E. Darwin, £500; Professor Pearson, F.R.S., and Mrs. Pearson, £500; Professor Arthur Schuster, F.R.S., £250; Mr. E. G. Wheeler, £250; Lord Roseberry, Lord Iveagh, Major Leonard Darwin and Major E. H. Hills, F.R.S., £100 each; Institute of Actuaries, £52 10s.

UNIVERSITY AND EDUCATIONAL NEWS

The annual meeting of the trustees of the Carnegie Foundation for the Advancement of Teaching was held in New York on November 17, when all the trustees were present. According to a press notice Mr. Carnegie gave $1,000,000 of the $5,000,000 which he had

promised in case the state-supported institutions were admitted to the benefits of the foundation. The endowment is $12,126,000, yielding an annual income of $590,000. Last year, it is said, the sum of $526,000 was paid for pensions to 370 professors and widows of professors. Forty-eight were added to the list for the year and fifteen died. The University of Virginia was added to the list of accepted institutions.

YALE UNIVERSITY has made important changes in the entrance examinations of the Sheffield Scientific School. The system is to be modified in the interests of elasticity, allowing many entrance options in studies, including substitutes for Latin. The plan is to make the examination scheme conform to the work of the preparatory schools, especially the high schools of the west. There is, however, no change in the direction of allowing entrance wholly or in part by school certificate.

DR. GEORGE HARRIS has presented to the trustees of Amherst College his resignation from the presidency to take effect not later than next commencement, when he will have reached the age of sixty-eight years.

THE following non-resident lecturers in highway engineering for 1911–12 have been appointed at Columbia University: John A. Bensel, M. Am. Soc. C. E., New York state engineer, Albany, N. Y.; Walter W. Crosby, M. Am. Soc. C. E., chief engineer, Maryland State Roads Commission, Baltimore, Md.; A. W. Dow, chemical and consulting paving engineer, New York City; Walter H. Fulweiler, Assoc. M. Am. Soc. C. E., chief chemist, United Gas Improvement Company, Philadelphia, Pa.; John M. Goodell, Assoc. Am. Soc. C. E., editor-in-chief, *Engineering Record*, New York City; Nelson P. Lewis, M. Am. Soc. C. E., chief engineer, Board of Estimate and Apportionment, New York City; Logan W. Page, M. Am. Soc. C. E., director, United States Office of Public Roads, Washington, D. C.; Harold Parker, M. Am. Soc. C. E., chairman, Massachusetts Highway Commission, Boston, Mass.; Charles P. Price, Assoc. Am. Soc. C. E., manager, American Tar Company, Malden, Mass.; H. B. Pullar, chief chemist, American Asphaltum and Rubber Company, Chicago, Ill.; John R. Rablin, M. Am. Soc. C. E., chief engineer, Massachusetts Metropolitan Park Commission, Boston, Mass.; Clifford Richardson, M. Am. Soc. C. E., consulting engineer, New York City; Philip P. Sharples, chief chemist, Barrett Manufacturing Company, Boston, Mass.; Francis P. Smith, M. Am. Soc. C. E., chemical and consulting paving engineer, New York City; Albert Sommer, Assoc. Am. Soc. C. E., consulting chemist, New York City; George W. Tillson, M. Am. Soc. C. E., consulting engineer, Borough of Brooklyn, New York.

AT Case School of Applied Science the new appointments are: Charles Fulton (Columbia School of Mines), recently president of South Dakota School of Mines, as head of the department of mining engineering; J. Burns Read (South Dakota School of Mines), recently mining engineer at Salmon, Idaho, as assistant professor of mining engineering; A. M. Holcomb (Worcester), recently instructor at Cornell University, as assistant professor of electrical engineering; Fred L. Bardwell (Massachusetts Institute of Technology), assistant professor of chemistry at Massachusetts Institute of Technology, as assistant professor of general chemistry; C. W. Bedford (Michigan), instructor at University of Michigan, as instructor in organic chemistry; C. W. Coppersmith (Case), recently with the Kilby Manufacturing Company, as instructor in steam engineering; Zay Jeffries (South Dakota School of Mines), general manager of the South Dakota Mica Company, as instructor in metallurgy; Sidney J. Lockner (Union), instructor at Lehigh University, as instructor in mathematics, drawing and descriptive geometry; Clyde M. Martsolf (Pennsylvania State College), recently with the American Telephone and Telegraph Company, as instructor in electrical engineering; W. A. Van Winkle (Michigan), assistant in chemistry at the University of Michigan, as instructor in qualitative chemistry; Roy Young (Purdue), recently with the Ideal Electric Company, as instructor in electrical engineering.

RECENT scientific appointments at West Virginia are: Wm. H. Alderman, formerly of the Experiment Station at Geneva, N. Y., to be professor of horticulture; Isaac S. Cook, formerly of Ohio State University, to be associate professor of agronomy; Roland P. Davis, formerly of Cornell University, to be associate professor of structural and hydraulic engineering; E. Dwight Sanderson, dean of the College of Agriculture, to be also, beginning January 1, 1912, director of the Agricultural Experiment Station.

DR. HAROLD E. EGGERS, of the Memorial Institute for Infectious Diseases, Chicago, has accepted an appointment as professor of pathology in the Harvard Medical School of China in Shanghai and will enter on his duties as such on February 1, 1912.

MRS. H. C. MCPHERSON has been made instructor in botany at the Oregon Agricultural College. Mrs. McPherson, who is the wife of Dr. H. C. McPherson, of the political economy department, held a graduate scholarship in botany at the University of Chicago until 1909, when she went to Michigan Agricultural College as instructor in botany.

DAVIS SPENCE HILL, Ph.D. (Clark), recently professor of psychology and education in the University of Tennessee, has been elected to a similar position at Tulane University.

MR. T. G. BEDFORD, M.A., Sidney Sussex, has been appointed demonstrator of experimental physics, and Mr. J. A. Crowther, M.A., St. John's, and Mr. H. Thirkill, B.A., Clare, assistant demonstrators of experimental physics, at Cambridge University.

DR. EUGEN KURZ, of the University of Münster, has been appointed head of the anatomical laboratory of the German medical schools at Shanghai.

DISCUSSION AND CORRESPONDENCE

THE EXILED NATURALISTS OF PORTUGAL

A DOCUMENT has recently been circulated, bearing the names of twelve Portuguese naturalists,[1] who have been exiled from their country by the new government, "on the pretext that they are Jesuits." Five have gone to Brazil, three to Belgium, two to Spain and two to Holland. These men were professors in the colleges of S. Fiel and Campolide, in Lisbon, and were known for their work in different branches of biology, and especially for the journal *Brotéria,* which they published. Perhaps the best known is J. S. Tavares, but it appears that all had done work on the fauna and flora of Portugal. In the course of years, they had established an excellent library of works on natural history, a laboratory for microscopic work, and had accumulated large collections, especially of Orthoptera, Lepidoptera, gall-insects and botanical specimens. The government ordered the arrest of these professors, and confiscated all their scientific possessions. "Nos livres, nos revues, nos instruments, nos collections, nos manuscrits, même les plus intimes, nous les avons perdus!" Two commissions were appointed, it seems, to discuss the questions involved. That on S. Fiel, where the principal collections were, did not include a single naturalist; instead, it consisted of a veterinarian, a physician, a professor and two lawyers, presided over by a particular enemy of the college. The Minister of Justice said to one of the arrested men, "If your collections are lost to you, they are not lost to science." Unfortunately, however, the collections were accumulated for special ends, and it will not be possible for others to make the best use of them. In many cases the specimens are not labeled, and in others they are marked with numbers, abbreviations, etc., intelligible only to their original owners.

"C'est pourquoi, les naturalistes de la *Brotéria* protestent bien haut devant le monde savant contre l'injustice sans nom sont ils sont les victimes; ils protestent au nom de leurs droits violés, ils protestent au nom de la science!"

It is probable that there is another side to this question, but granting the accusations of their enemies, that they are Jesuits, and (I suppose) opposed to a republican form of gov-

[1] A. Luisier, A. O. Pinto, A. Redondo, A. Silvano, C. Torrend, C. Mendes, K. Zimmermann, J. S. Tavares, J. Foulquier, M. Martins, M. Rebimbas, P. Vieilledent.

ernment, there is still no justification for the action taken in depriving them of their scientific materials. No doubt the government claims that all these things belong to the colleges, and not at all to the particular men; but while this may be true in a sense, all scientific men will agree that they had rights in the matter which have been apparently ignored.

Would it be possible for some representative scientific body to appoint and pay the expenses of a man who would enquire into all the facts, and furnish a carefully considered report? Should such a plan be contemplated, preliminary enquiries might be made to see whether the case of the exiles was apparently good. If the report supported the exiles, organized protests from the scientific bodies of different countries might be appropriate.

T. D. A. Cockerell

University of Colorado

"DOMESTICATED ANIMALS AND PLANTS"

To the Editor of Science: I write to correct an impression made by Professor Cockerell's criticism of "Domesticated Animals and Plants" in Science, issue of October 27. The impression left by this article is that the errors he mentions are to remain uncorrected, whereas the facts are they were corrected months ago.

I have no desire to discuss the criticisms made further than to relate how the unpardonable error as to the types of pigeons occurred, which may be of interest to the psychologist if not to other scientists. The manuscript was submitted in advance of publication to a number of individuals, and every attempt was made to utilize and harmonize the criticisms and suggestions. This resulted in the practical reorganization of the copy. My original intention had been to use cuts and descriptions of both the rock pigeon and the passenger pigeon, and how the two became so completely confused in the final make-up is a mystery which I have not yet solved. It is perhaps unnecessary to say that for thirty years I had known that the rock pigeon is the foundation of the domesticated types, and the appearance of the plates was, perhaps, as much of a surprise to me as to others. The only explanation is that the proof was running during my illness and a press of other work, and my own attention was directed chiefly to eliminating the difficulties that had arisen by the rearranging of the text and the references. The publishers are in no wise to blame for this mix-up, for which I accept full responsibility and which was corrected at the first possible moment.

The same remarks apply to the "definitions" mentioned and to one or two other errors not mentioned by Professor Cockerell.

I have only this remark to add; namely, the book was prepared, after repeated suggestions, for boys and girls in the secondary schools and not for the elucidation or even the discussion of such disputed points among scientists as the ramifications of Mendelism or the controversy between biologists and mathematicians. My regret is for the absurd errors that crept into this volume, not for statements that may be disputed when taken out of their connections.

E. Davenport,
Dean and Director

QUOTATIONS

PENSIONS AND THE LEARNED PROFESSIONS

It is part of the undisciplined heritage which we call human nature to assert rights strenuously and assume obligations reluctantly. With the growth of the altruistic spirit, which cultivates thinking in the larger terms of social benefit, the sense of public obligation is gradually and laboriously maturing. There is no idea that stands in greater need of this beneficent socialization than that conveyed by the term "pension." American experience had been peculiarly unfortunate in linking the term with one of the greatest scandals of public extravagance, showing human quality at its worst. It is also unfortunate that the pity extended to old age and poverty and lack of thrift, has enveloped the term in an atmosphere of charity. Foreign examples and an attention to principles should have kept in mind the more dignified sense

which the pension may carry as a recognition of merit, a badge of honor. It will ever be impossible and perhaps undesirable to separate the economic responsibility applicable to all meritorious servitors of society from the special recognition to be accorded those who might well be relieved of economic pressure, or to those who through devotion to intellectual or moral purpose have been debarred from the more lucrative pursuits. The distinction is none the less to be held and clarified, despite the similar resultant expression; moreover the sturdy justice and even the humanitarian sympathy that invites to the acceptance of economic responsibility is itself congenial to the sentiment that finds a duty and a pleasure in lending honor and dignity to a pension conferred in recognition of distinguished or altruistic service.

Our sole institution for recognizing this claim to recognition of the learned classes owes its existence to the wisdom and beneficence of one man—the Carnegie Foundation for the Advancement of Teaching. The present reflections are prompted by the opinions of its president, Dr. H. S. Pritchett (*Popular Science Monthly* for November), in discussion of the "Moral Influence of a University Pension System"—or let us say frankly by the considerations which are conspicuously absent from his presentation. We stand ready to accord Mr. Pritchett the authority of judgment as to management, growing out of his official experience and accumulated wisdom; but we can not grant him by virtue of his office any special warrant in the appraisal of wise principles which management is to follow, other than that conferred by the possession of insight and ideals and the personal qualities to carry them to expression. We are ready to accept his summary that "the experience of the world seems to point strongly to the conclusion that on the whole a contributory form of pension is likely to be more just and least harmful"; and we can not withhold a regret that the experience of the world was not available five years ago when the contrary policy was adopted by the Carnegie Foundation. Let it be recognized that every pension system applicable to many and to all sorts and conditions of men presents problems of management and requires economic considerations of the greatest good—or as Mr. Pritchett seems to view it, the least harm—of the largest number. The foundation must balance its books by economic as well as by intellectual and moral standards. Yet fundamentally the selection of university professors of selected institutions as beneficiaries carries an honor and a privilege as well as a benefit. This aspect of the pension must dominate and guide the spirit of the institution as it inspired Mr. Carnegie's deed of gift and appealed to his wisdom and philanthropy; and considerations of management must on no account or pretext be permitted to disturb the trend of a far-reaching purpose, or to encroach upon the field where policy is sacred and politics profane.

Mr. Pritchett's article gives the impression of an official weighed down with administrative annoyances, and deeply concerned to avert the impending demoralization of the professor when confronted by the remote prospect of an allowance granted without supervision or under the care of a trustee or guardian, if such should be granted at an age when the allowance might still be used for the advantage of his career. Mr. Pritchett's doubts extend to many distressing aspects of the professor's character. Under these circumstances it would be as fair as kind that President Pritchett should be relieved of the burdens of his office, which might well be placed in the hands of someone more strongly convinced of the worthiness of the academic class as beneficiaries, more deeply interested in furthering the purposes for which the foundation was established. The symptoms, we venture to diagnose, point to another case of the prevalent malady of hypertrophy of the executive centers of the spinal cord, and atrophy of the higher cerebral centers of intellectual vision and directive purpose. The suggestion is obvious that the malady may be of contagious origin, since the board of trustees is made up of college presidents. But is it not translucently clear that this institution, of such

profound significance for the academic life of the nation and of such great potentiality for intellectual interests—an institution founded purely and simply for the benefit of one of the learned professions, and unhampered by fund-eating buildings, or the clamor of students, or the demands of the public, or the contentions of rivals—might well serve as an exemplar by determining its measures in the larger spirit of academic welfare? In benighted Germany professors are actually summoned to councils of state; in enlightened America they are not granted a single representative on the council of an institution founded exclusively for their own interests. . . .

We have said more of the Carnegie Foundation and less of the value of pensions for the learned professions than was our intention. But the concrete ever engages the attention; and it is often the more urgent and useful measure to set right the faulty steering in the short tack of the moment on the skiff upon which we are embarked, than to chart the future course of the great ship of state that must eventually carry our ventures. Human highways, moreover, are not like the broad open sea; they get clogged with tradition, and littered with the débris of precedent, and the retracing of steps is often peculiarly troublesome. But the two phases of the theme are of one nature. It is an underlying distrust of the man of learning, the hesitant recognition of his value for the intellectual resources of the nation, that makes public interests dilatory in providing such honorable recognition as the pension stands for, and as well leads to weak and floundering consideration and operation of the measures adopted. Born of the same feeble confidence is the emphasis placed upon administrative restrictions and the exaltation of near-sighted business prudence. All this makes for an exaggerated intolerance of the minor disadvantages or even abuses inherent in every good movement, and for a tragic disregard of the great lost opportunities. We believe in higher education, in the value of the learned professions; we should like a goodly share of the great contributions to science and invention, to art and literature, to noble thoughts and human endeavors, to emanate from Americans; but we are chary or stupid in providing the free and effective play of forces, the favoring environment which gives these blossoms their nurture. We see no reason why roses should not be grown like cabbages, and orchids like peas—and we want the roses thornless. We insist that the business methods that make the one crop flourish must be efficacious for the other. Foreign example is unconvincing, too heavily laden with conditions condemned by a triumphant democracy as out-of-date. And so our statesmanship in politics carries the flavor of the market-place and the outlook and insight of the "boss"; and the guidance of cultural interests, reflecting a kindred narrowness of perspective, fails or imperfectly succeeds by reason of the absence of just that superadded but indispensable touch of intellectual integrity and spiritual vision, that at that level divides the worthy from the unworthy results. Such is the law of the upper ranges of human quality and human standards. Defections wholly pardonable and not over-serious in their consequences for the ordinary interests of life, become fatal for the extraordinary ones. When we shall have learned this lesson and rendered to each of the learned classes the tribute that is its due, and shall entrust their interests to those imbued with the spirit thereof, we shall institute more liberal provisions for their welfare and administer more liberally those that favoring circumstances permit us to establish. Meanwhile the learned classes may accept the imposed or self-imposed burden of appreciatively though critically proclaiming the merit of good measures, while maintaining the struggle and the hope for the advent and survival of the best.—*The Dial.*

SCIENTIFIC BOOKS

Leonhardi Euleri, Opera Omnia. Sub auspiciis Societatis Scientiarum Naturalium Helveticae edenda curaverunt FERDINAND RUDIO, ADOLF KRAZER, PAUL STÄCKEL.

Series Prima, Opera Mathematica, Volumen Primum. Leipzig und Berlin, B. G. Teubner. 1911. Pp. xcv + 651.

Leonhard Euler (1707–1783) has been the most prolific mathematical writer of all past times. The great extent of his writings delayed the appearance of his complete works until the day when big scientific projects can be carried through by international cooperation. The mathematical world had never before witnessed such extensive international collaboration in a financial way, as when the means for publishing the forty-five large volumes of Euler's complete work were secured. While Euler's native country, Switzerland, did the most in proportion to her means, by contributing more than one hundred thousand francs towards the expense of this publication, many other countries, especially Germany, Russia and France, aided very liberally.

In our own country, the American Mathematical Society contributed five thousand francs and our libraries, doubtless, contributed much more in the form of subscriptions. The great academies of Paris, Berlin and St. Petersburg, of which Euler was a member, each subscribed for forty copies of the complete works, and thus aided the project not only financially, but still more by their great scientific influence. The last of these three academies contributed also five thousand francs in money. The total amount of subscriptions and money collected before the publication began amounted to over four hundred and fifty thousand francs.

The volume before us is in German, with the exception of a paper by J. L. Lagrange entitled, "Additions à l'analyse indeterminée," which appeared for the first time in the French translation of Euler's algebra in 1774. In addition to an extensive eulogy on Euler by Nikolaus Fuss, and a few introductory notes in reference to the publication of Euler's complete works, the present volume is devoted to a very elementary introduction to algebra under the title "Vollständige Anleitung zur Algebra mit den zusätzen von Joseph Louis Lagrange, herausgegeben von Heinrich Weber."

This algebra was prepared for publication after Euler had become totally blind. Euler desired to prepare a work which could be understood by every one and which would be complete in every particular. He dictated it to a servant who had been a tailor and knew nothing about mathematics beyond the calculations involved in elementary arithmetic. It is said that this tailor understood it completely, and, by the time the more difficult subjects were reached, he could work out the details with ease.

The work was soon translated into Russian and into French, and it exercised a greater influence on the development of algebra during the eighteenth century than other work. It was translated into English in 1797 and a very large number of editions in various languages have appeared. While the greater part of it is devoted to very elementary questions in algebra, it proceeds gradually to such matters as the general solution of the cubic and the biquadratic equations, and especially to indeterminate analysis. In the latter part it is proved that the sum of the cubes of two rational numbers can not be the cube of such a number. This is a special case of the noted Fermat's theorem, for the complete proof of which a prize of twenty-five thousand dollars is now offered through the Königliche Gessellschaft der Wissenschaften in Göttingen.

The complete works of Euler are to appear in three series. The first of these is devoted to pure mathematics and will probably consist of 18 volumes. The second series, composed of 16 volumes, is devoted to mechanics and astronomy; while the third series, composed of 11 volumes, is devoted to physics, works of various contents and letters. The different memoirs will be republished in the same language in which they first appeared.

G. A. Miller

Applied Electrochemistry. By M. de Kay Thompson, Ph.D., Assistant Professor of Electrochemistry in the Massachusetts Institute of Technology. New York, The Macmillan Company. 1911.

The subject of applied electrochemistry has now become so large and important that a

book in English dealing with this branch of science demands particular attention.

The great difficulty in writing such a book is in the rapid developments which are being made in the subject, and it seems as if the method followed in Germany, of issuing monographs on a particular branch of applied electrochemistry, was really more practical than attempting to include them all in one book.

In the present volume Professor Thompson has fifteen chapters, ten of which deal with electrolysis in the wet way, the remaining chapters being devoted to the electric furnace and its products.

There are necessarily a great many processes to be described in such a program, but notwithstanding this a considerable part of the space is devoted to theoretical considerations. While the theoretical discussion is important, there are many good books which deal with this exclusively, and it would seem perhaps better to have expanded the description of the actual processes themselves.

Thus the refining of copper, which is an electrochemical process of the first magnitude, is described in seven pages, and aluminium, which is manufactured on a very large scale, is dealt with in five pages, and the actual process is described in a few lines without illustration.

The book as a whole, however, serves a very useful purpose, giving a great deal of information on a long list of subjects. Abundant references are furnished and the illustrations are excellent. One typographical error occurs, however, which seems a pity, the name of Moissan is invariably printed *Moisson.*

The contents of the book is as follows: Coulometers, Electrochemical Analysis, Electroplating, Winning and Refining Metals in Aqueous Solution, Reduction and Oxidation, Electrolysis of the Alkali Chlorides, Electrolysis of Water, Primary Cells, The Lead Storage Battery and the Edison Storage Battery, The Electric Furnace and Products of the Arc and Resistance Furnaces, Electrometallurgy of Iron and Steel, Fixation of Atmospheric Nitrogen, The Production of Ozone, Appendix, Name and Subject Indexes.

SAMUEL A. TUCKER

Lippincott's New Medical Dictionary, a vocabulary of the terms used in medicine, dentistry, veterinary medicine and the allied sciences, with their pronunciation, etymology and signification, including much collateral information of a descriptive and encyclopedic character. By HENRY W. CATTELL, M.D. Philadelphia and London, J. B. Lippincott Company. 1911. Freely illustrated with figures in the text. Second edition. 8vo. Pp. xvi + 1108. Price $5.

There is hardly any field of science that is more in need of a technical dictionary than medicine. One might trace back the first attempt to provide the medical profession with such a work as early as circa 1300, when Simone Cordo of Genoa wrote his "Synonyma medicinae sive clavis sanitatis" (editio princeps, Milano, 1473). In the United States the first medical dictionary (not taking into consideration the American editions or reprints of English medical dictionaries) to be issued was published in 1808 by John Redman Coxe, of Philadelphia (1773–1863), professor in the University of Pennsylvania and one of the leading American physicians in the first half of the last century.

Since then here and abroad numerous medical dictionaries have been published. As one of the best, if not the best, in another language, we consider Walter Guttmann's "Medizinische Terminologie" (4 Auflage, Berlin, 1911). In England Richard D. Hoblyn's dictionary of terms used in medicine and the collateral sciences (14th edition, London, 1909) takes a very high rank.

In Lippincott's "New Medical Dictionary," written by Dr. Henry Ware Cattell, of Philadelphia, we have a work which not only equals those just mentioned, but even excels them in completeness, thoroughness and encyclopedic method. However, it is only just to state that owing to the low educational requirements and inadequate instruction in many of our medical colleges an American medical dictionary must be written under conditions entirely different from those in other coun-

tries. A dictionary for the use of the medical profession in this country must be prepared along broader lines and must include many definitions which we search for in vain in those of other countries. This makes the task much more difficult, taking into consideration the wonderful progress of medicine and its collateral sciences in the last few years. Only a physician of the highest professional attainments can undertake such a work, and the publisher must be congratulated on entrusting this work to such a man as Dr. Cattell. His editorial experience as editor of *International Clinics,* his laboratory work in some of our best medical institutions and his high standing as pathologist and practitioner make him eminently fitted for the task. The immediate predecessor of the present book was Lippincott's "Medical Dictionary," published in 1897 under the editorial collaboration of the late Professor John Ashhurst, Professor George A. Piersol and Professor Joseph P. Remington. For this edition Dr. Cattell had the able assistance of other collaborators to whom he gives proper credit in the preface. One will understand what an amount of painstaking labor was involved in the preparation of the present work when we state that Dr. Cattell devoted five years to its completion. The medical lexicographer is generally confronted with such an "embarras de richesse" regarding his material that it taxes an author's greatest editorial ability to overcome the difficulty satisfactorily. But we must admit, that our author, by a wise economy in the grouping of words, has not only solved this problem, but also succeeded in such a way that his medical dictionary contains more words than any other. For instance, all words which begin with the same initial element or are of the same etymological origin are grouped together. This space-saving method has made it possible to insert so many new words and to give the dictionary its encyclopedic character. The etymology of words derived from foreign languages is always given, not, however, immediately after the word, but after the definition, following here the arrangement of the "Standard Dictionary." In this connection we may remark that the printing of the Greek alphabet with its proper pronunciation in English seems extremely appropriate, taking into consideration the large number of physicians who are not such apt Greek scholars as Dr. Achilles Rose. Eponymic terms are profusely given, and at the same time accurately and concisely, which is a very important matter. The cross-references are ample and are one of the most useful features of the book. The author's aim to furnish the medical student, the practitioner and the laboratory worker with a dictionary of moderate compass and at a reasonable price is more than fulfilled. It must indeed be very gratifying for the author and for the publisher, that this book, which was first published in August, 1910, met with such success that it had to be reprinted within three months after publication and issued in a new edition within a year. The new edition is materially increased; about 500 new words have been inserted, and 71 new illustrations have been added.

Take it all in all we do not hesitate to recommend Lippincott's "New Medical Dictionary" as an indispensable tool for the medical profession at large.

Felix Neumann

Surgeon General's Library,
Washington, D. C.

THE MEETING OF THE ASSOCIATION OF AMERICAN UNIVERSITIES AT THE UNIVERSITY OF CHICAGO[1]

Nearly every one of the twenty-two universities constituting this association was represented at this meeting, the larger number of them by its president and at least one delegate, as was the case with Minnesota.

The first paper presented was by Dean Greene, of Illinois, on the question of the relative advantages of organizing university departments on the usual plan of permanently retaining a single head *versus* the Harvard plan of a departmental committee under a chairman.

It was shown that while during the period during which a department is small and in-

[1] From the *Minnesota Alumni Weekly.*

creasing rapidly in size a single permanent head probably makes for efficiency and continuity of policy, a far different set of influences come into play after a department becomes large enough so that it contains or should contain a number of men of first-class ability and rank. Such men will not be content to remain subordinate to any departmental head, not because they themselves desire to discharge the time-consuming administrative duties of the head of a department, but because of the subjection involved in occupying a subordinate position. These inherent difficulties of administration are avoided by the plan of a departmental committee, whose chairman may be changed when circumstances require it. Sufficient independence may be secured to the individual professor on this plan and in a large department sufficient continuity of policy as well, without the deadening inflexibility which often accompanies the administration of a conservative permanent head. The implied conclusion of the paper was that our larger departments ought one after another, as they became full grown, to change their organization and adopt the committee plan in order that full advantage may be taken of the talents of the younger members of the departmental faculty in the way of administration, etc., and thus permit older men to devote more time to productive scholarship. There seems to be no reason why both plans of organization should not coexist in the faculties of the same institution.

The second paper was by President Judson, of Chicago, as to how the teaching time of professors may be most advantageously distributed between college work, both elementary and advanced, and graduate work. This paper treated more at length the questions which President Judson discussed in his address at the inauguration of President Vincent, insisting that each professor should be used mainly for those activities for which he is best fitted, but that young and untried men be early given a reasonable opportunity to devote some small portion of their time to advanced work by which they might make good and demonstrate their aptitudes of advanced work, and when they have so demonstrated their fitness for such work it is time to give them larger scope.

Many side questions were treated in the paper, among them the practical difficulty the administration has in suitably appraising the relative importance of the various researches for which appropriations are asked. It too often happens that the personality of the applicant and the eagerness of his request or some other adventitious circumstance enables him to obtain undue aid for his work while more meritorious work is unable to get financial assistance. A suitable buffer between those who ask for aid and those who grant it is very much to be desired.

This gave opportunity to explain the unique plan just adopted at Minnesota by which all requests for aid are submitted for consideration to a research committee and grants are made on the basis of its recommendations. These two papers and the accompanying discussions occupied the two sessions of Thursday, October 26. A reception followed in the evening at the residence of President Judson.

The final paper by President Lowell, of Harvard, treated the disadvantages of having college and university degrees granted on the basis of examinations which cover the several courses singly, instead of having them depend on comprehensive examinations covering broad subjects and embracing a number of courses.

It was in the early days the practise to confer the degree of B.A. after a single final examination on the whole course. Biennial examinations were the rule at Yale and elsewhere in the past generation; and, later, annual examinations were held. President Lowell insisted that such examinations, in which the questions set are not framed by the instructors themselves, are essential to high scholarship, be the examinations for academic degrees or professional degrees. Such is the practise in the English universities where the first duties of professors have to do with examinations rather than with teaching. Indeed the University of London was created merely as an examining body. It was shown in the discussion that any such change in the character of degree examinations in America would

profoundly influence the ideals, the methods and character of academic and professional education.

The concluding session of the meeting was an informal conference of deans of graduate schools for discussion of questions of policy and administration for mutual enlightenment and better understanding of their common problem, how best to foster the most advanced work done in our universities. Such a conference as this had been held at previous meetings and had been found to be so necessary that a number of deans of graduate schools were in attendance at their own expense who were not delegates to the association. The questions arising in the administration of graduate schools are so new and important that it is extremely desirable to put the united wisdom and experience of all at the disposal of each, as can be accomplished in no way so well as the free and informal interchange of a round table conference. The meeting as a whole was most useful in bringing together and helping to fuse into a consensus of opinion and action the men controlling the leading universities of the country.

The annual report to be published later will contain the papers and discussions in full, excepting the conference of deans.

H. T. Eddy

SPECIAL ARTICLES

THE RÔLE OF DIFFERENT PROTEINS IN NUTRITION AND GROWTH

Interest in the study of the problems of nutrition has largely been coincident with the development of the chemical aspects of physiology, in distinction from the physical and mechanical phenomena which earlier attracted the attention of investigators. The subject of nutrition has, in large measure, been considered in the past from what might be designated as a statistical standpoint. The balance of income and outgo of energy and matter, nutritive needs and dietary standards, and the effect of external factors on these, are illustrations of the type of questions which has called for discussion. With the progress in the study of physiological chemistry have come important additions to our knowledge of the make-up of the foodstuffs and of the real significance of the processes which take place in the alimentary tract. The conception of digestion as a simple act of solution has evolved into that of an intricate and carefully regulated chemical transformation. The intermediary changes which characterize the metabolism of food materials after absorption and incident to the real nutritive reactions of the body within its tissue cells have at length become the subject of experimental inquiry.

With this development has come about an appreciation of the *specific* rôle of foodstuffs. Various incidents have favored this trend of physiology. The study of enzymes and their striking specificity has served to emphasize the necessity of digestion before the nutrients can satisfy their purposes. Observations on the unique responses of various parts of the alimentary tract to different kinds of chemical compounds have brought to light the remarkable interrelations of the secretory and motor functions of the digestive tract and their dependence on special (chemical) stimulants. But more important than all this, perhaps, have been the disclosures of the past decade in respect to the chemical structure of the so-called proximate principles, and the proteins in particular. The development of this field of study has been little short of epoch making, so that it seems timely to begin to apply some of the newer knowledge to the investigation of problems in nutrition.

The idea that proteins of different origin may possess an unlike physiological value is not entirely new. Gelatin, for example, has long been pointed out as an illustration of an inadequate protein. It has been impossible experimentally to sustain life with a diet in which gelatin formed the sole source of nitrogenous intake. To-day one can cite other illustrations of proteins, *e. g.*, zein, gliadin, hordein, casein, which lack some of the characteristic amino-acid complexes readily obtainable from other albuminous materials which are vaguely regarded as "complete." In still other cases, *e. g.*, edestin and glutenin,

the relative proportions of these constituent complexes are so markedly different from the average as to raise the question of comparative nutrient values. Overabundance of glutaminic acid groups must necessarily be attended by relative deficiency in other so-called "building stones" of the protein fundament. If, then, a minimum of some of these is an indispensable requirement of tissue maintenance or growth or repair, problems of relative values at once suggest themselves.[1] To this may be added the question of protein synthesis in animals which has been so vigorously debated in recent years. Here we touch upon problems quite independent of the energy needs of the organism, yet equally important. No sooner has the idea of the isodynamic replacement of nutrients found acceptance, than the practical limitations of this law are subjected to critical examination.

The foremost reason why so little is known in the directions noted lies in the fact that the individual foodstuffs have, with very few exceptions, rarely been examined heretofore in respect to their actual nutrient rôle. Meat and cereals have, it is true, been crudely analyzed in terms of protein ($N \times 6.25$), fat, carbohydrate and ash, and fed as assumed mixtures of the composition indicated. Physiologists are, however, just beginning to recognize the extreme chemical complexity of such animal and plant tissues. How much of the nutritive failures or successes shall be ascribed to either presence or paucity of some incidental component, as lime or iron, as lipoid or nitrogenous "extractive" of specific physiological import, such as is attributed to the "hormones"?

It is, indeed, only in very recent years that the perfection of biochemical technique has permitted the preparation of isolated proteins in what may be called comparative purity. We believe, from the experience which one of us has gained during many years of experiment in this field, that the vegetable proteins to-day are in general easier of access for chemical investigation and isolation than the related compounds of animal origin. And it is this fact which encouraged us to undertake what Carl Voit long ago proclaimed as the ideal method, viz., the feeding of isolated foodstuffs under controllable conditions. The laborious and costly investigations which are under way have been made possible by the cooperation of the Carnegie Institution of Washington. A detailed report of the first two years' work and the literature pertaining thereto is available in Publication 156, Parts I. and II., of the Carnegie Institution.[2] The following pages are intended to call attention very briefly to some aspects of these studies.

We have undertaken to investigate certain features of nutrition by feeding isolated food substances to albino rats. The selection of this animal has been determined by several in part obvious considerations. The white rat is easily reared and cared for. Its small size reduces the food requirement to a magnitude which falls within the range of experimental possibility where the preparation of special dietaries by laborious processes is a fundamental prerequisite. Furthermore, the longevity of this animal is, according to Donaldson, about three years; so that the first year of life corresponds to a long span in terms of human years. Not insignificant is the additional fact that the white rat has in recent years been made the subject of exceptionally extensive measurements in respect to growth and various features of development at the Wistar Institute in Philadelphia. In this way physical standards, so to speak, have been established for this animal.

At the outset numerous problems of experimentation have arisen quite apart from the main question itself. Can rats be kept in health indefinitely under cage conditions which permit the control of the food intake and collection of the excreta? For the description of the cages and experimental technique we must

[1] These and related questions are discussed in detail by Mendel, "Ergebnisse der Physiologie," 1912, XI.

[2] "Feeding Experiments with Isolated Foodsubstances," by Thomas B. Osborne and Lafayette B. Mendel, with the cooperation of Edna L. Ferry, Carnegie Institution of Washington, Publication 156, Parts I. and II., 1911.

refer to our detailed publication (Part I.). How successful this has been is best answered by the statement that rats have been maintained for many months at all ages with apparent success. Far more important than the ability to withstand confinement in a restricted space has been the demonstration of the possibility of maintaining rats on an "artificial" food paste of unaltered uniform composition during a large span of their life. Herein we have apparently been far more successful than any of our predecessors; for the supposed *monotony* of diet has been the stumbling block leading to failure in the records of various investigators.[3] Their animals have failed to eat and have declined as an obvious result of insufficient food intake. We are inclined to lend emphasis to the result of the excellent hygienic environment and care of our animals. And whereas nutritive decline has commonly been attributed to the anorexia consequent upon the monotony of diet, we are more than ever inclined to shift the explanation in many such cases to malnutrition as a primary cause. From this point of view improper diet and malnutrition may be the occasion rather than the outcome of the failure to eat—a distinction perhaps not sufficiently recognized heretofore.

As the criterion of the nutritive status of the rats their body weight has been adopted, and this has proved to be an advantageous index. It soon became apparent that one must distinguish sharply between maintenance and growth in any such study of nutrition. The white rat shows a very characteristic curve of growth (plotted from the body weight) which becomes practically stationary within 300 days. According to Donaldson the body weight changes from 5 grams at birth to 270 grams in the case of the male, or 225 grams in the female at the age of 300 days. To judge of the effect of a dietary régime by noting the subsequent duration of life, as is still frequently done by investigators, is misleading; for the incidence of death may depend on the previous nutritive condition—the store of fat and glycogen—where food is insufficient. An error less readily appreciated consists in describing the nutritive status as necessarily satisfactory because an animal maintains an undiminished body weight over long periods under the conditions imposed. A man who maintains his weight may be in excellent nutritive condition; but a child which does likewise is *failing to grow*. Childhood demands of a perfect ration the possibility of normal *growth,* not simply *maintenance*. This can not be emphasized too strongly. Furthermore, growth in the sense of an increase in the size of some structural part of the body or some organ may proceed independently of the correlated development of the body as a whole. Even with the existence of unquestionable malnutrition, skeletal growth may manifest itself in a conspicuous degree; so that the length or height of an individual may markedly increase while the total body weight remains stationary or even declines. One part of an organism may thrive at the expense of other tissues. The complexity of these relationships of absolute and relative (or proportionate) growth have likewise commanded attention in our experiments.

A study of physiological literature will make it evident that no convincing reply has been given to the question: can life be maintained and is growth possible with a *single* protein in the dietary. "Protein" has been used in this connection in a generic sense; and one of the (chemically) simplest foods, milk, contains at least two proteins of marked individuality. Casein and lactalbumin are chemically unlike. How widely two extensively used food proteins may differ in their chemical make-up is indicated below.

The individuality of proteins of different biological origin is further indicated by their specific immunity reactions. The published feeding experiments in which a single purified protein has been administered to animals are all limited in their duration to periods of days or weeks which are too brief to furnish convincing data. Indeed, one will scan the literature in vain for properly controlled experi-

[3] These earlier studies are reviewed in Publication 156, Part I., Carnegie Institution of Washington, 1911.

Amino-acids	Casein[4] Per Cent.	Zein[5] Per Cent.
Glycocoll	0.00	0.00
Alanine	1.50[4]	9.79
Valine	7.20[4]	1.88
Leucine	9.35[6]	19.55
Proline	6.70[7]	9.04
Aspartic acid	1.39[4]	1.71
Glutaminic acid	15.55[4]	26.17
Phenylalanine	3.20[8]	6.55
Tyrosine	4.50[9]	3.55
Serine	0.50[10]	1.02
Oxyproline	0.23[10]	——
Histidine	2.50[11]	0.82
Arginine	3.81[11]	1.55
Lysine	5.95[11]	0.00
Tryptophane	1.50[8]	0.00
Diaminotrioxydodecanic acid	0.75[12]	——
Ammonia	1.61[13]	3.64
Sulphur	0.76[14]	0.60
Phosphorus	0.85[14]	0.00

ments in which isolated and purified proteins have been fed successfully.[15]

Without citing here the numerous failures and the successive changes instituted in our earlier trials, we may briefly call attention to some of the purely "nutritive" factors which have had to be taken into consideration. The energy requirement must obviously be satisfied in an *available* form. A minimum protein requirement must likewise be provided in any event. Experiments which are to continue over more than very few days must include a *suitable* quota of inorganic salts—so-called mineral nutrients. This is in itself a problem of fundamental importance, the study of which has barely been begun in any synthetic way. One may, it is true, imitate the "ash" of milk or blood; but the elements occur here in combinations quite different from those prevailing in the tissue fluids themselves or in the native foods. The balance of acid and basic groups, the changing need for individual elements like phosphorus, calcium, chlorine and iron, furnish a series of complex variables which are probably as indispensable to certain aspects of nutrition as they are unappreciated. If to all this is added the uncertain significance of the as yet largely unidentified compounds such as cholesterol and phosphatides which occur in all natural food mixtures, the experimental difficulties begin to appear in their true light.

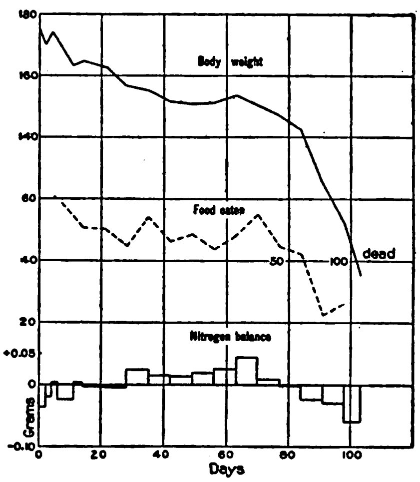


Fig. 1. (Taken from Carnegie Publication No. 156, page 26.) Showing the continued decline of a rat on a dogbiscuit-lard diet for 103 days.

At the outset it is only fair to remark that a successful feeding experiment with isolated food mixtures is of greater import than a

[4] Osborne and Guest, *Journal of Biological Chemistry*, 1911, IX., p. 333.

[5] Osborne and Liddle, *American Journal of Physiology*, 1910, XXVI., p. 304.

[6] Levene and Van Slyke, *Journal of Biological Chemistry*, 1909, VI., p. 419.

[7] Van Slyke, *Berichte der deutschen chemischen Gesellschaft*, 1910, XLIV., p. 3170.

[8] Abderhalden, *Zeitschrift für physiologische Chemie*, 1905, XLIV., p. 23.

[9] Reach, *Virchow's Archiv*, 1899, CLVIII., p. 288.

[10] Fischer, *Zeitschrift für physiologische Chemie*, 1903, XXXIX., p. 155.

[11] Osborne, Leavenworth and Brautlecht, *American Journal of Physiology*, 1908, XXIII., p. 180.

[12] Fischer and Abderhalden, *Zeitschrift für physiologische Chemie*, 1904, XLII., p. 540.

[13] Osborne and Harris, *Journal American Chemical Society*, 1903, XXV., p. 323.

[14] Hammarsten, *Zeitschrift für physiologische Chemie*, 1883, VII., p. 227.

[15] Cf. Osborne and Mendel, Publication 156, Part I., Carnegie Institution of Washington, 1911, for the literature on these topics.

failure may be; for ill health may be occasioned by incidents quite apart from those already outlined. Accident and acquired disease, unrecognized or uncontrollable, enter into the life of every individual and serve to upset an otherwise normal nutritive equilibrium.

Turning to the present experiments, our earlier attempts were largely based on those of our predecessors. Comparative trials with food mixtures precisely alike except for both content and character of the inorganic ingredients soon showed the great importance of this feature. A fairly suitable salt mixture was thus empirically selected. The table below may serve to illustrate the character of the earlier food mixtures which experience showed to be most suitable.

In such a mixture the protein can be varied without serious change in the fuel value. With one protein, viz., zein from maize, nutritive decline was apparent from the outset. The failure, as actual investigation showed, can not be attributed solely to poor utilization. With all the other proteins, such as casein, legumin, edestin, glutenin or gliadin, in the mixtures indicated, grown rats have been

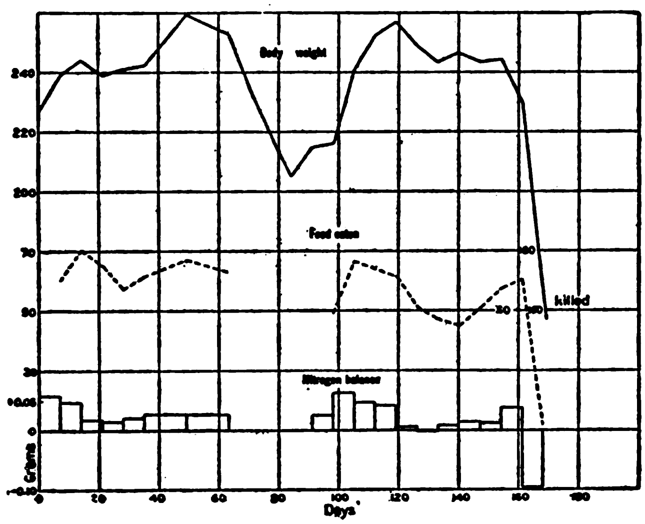


Fig. 2. (Taken from Carnegie Publication No. 156, page 42.) This rat was fed for 169 days on a diet containing pure casein as the only protein.

	Per Cent.
Isolated protein	18
Cane sugar	15
Starch	29.5
Lard	30
Agar-agar[16]	5
Salt mixture	2.5
	100.0

[16] This indigestible carbohydrate was added to furnish "roughage" in the diet. Cf. Mendel, *Zentralblatt für Stoffwechsel*, 1908, No. 17; Swartz, "Nutrition Investigations on the Carbohydrates of Lichens, Algæ, and Related Substances," *Transactions Connecticut Academy of Arts and Sciences*, 1911, XVI., pp. 247–382.

maintained in body weight for much longer periods than we have found recorded by previous investigators.

From many protocols we present three in graphic form; the first to illustrate a failure from the outset, the second and third as examples of a relatively successful attempt over a period of 169 days and 259 days, respectively.

In every case—and we might cite very many such experiments under varied conditions—a decline ultimately ensued leading to death unless a dietary change was instituted.

It early seemed unlikely that the protein was responsible for failures of this character; for this foodstuff forms so large an essential

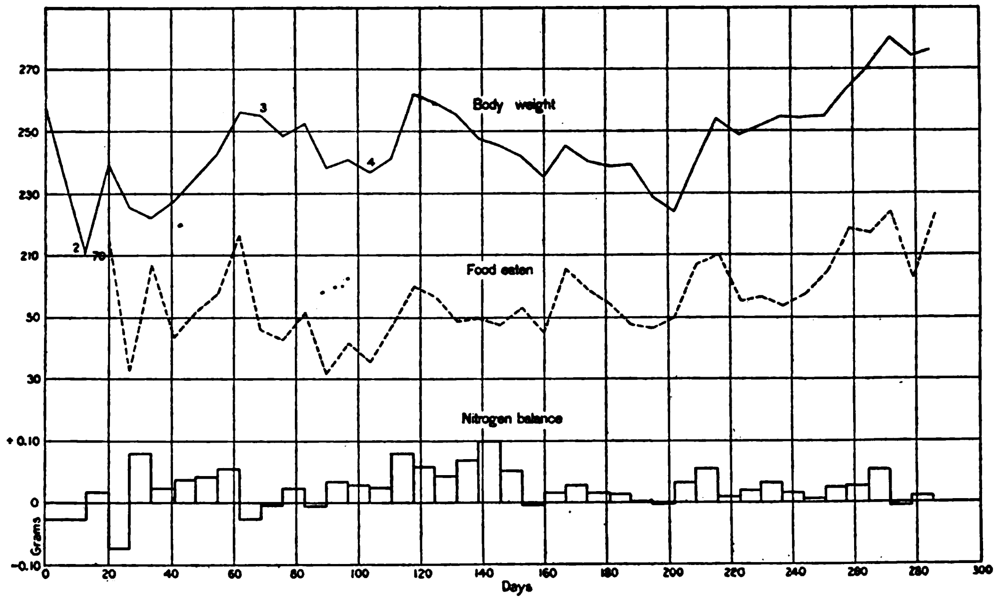


FIG. 3. (Taken from Carnegie Publication No. 156, page 49.) This rat was fed 69 days on a diet containing casein and glutenin as the sole proteins, followed by a period of 259 days in which glutenin formed the sole protein of the diet. Only a portion of the duration of this experiment is reproduced in the figure.

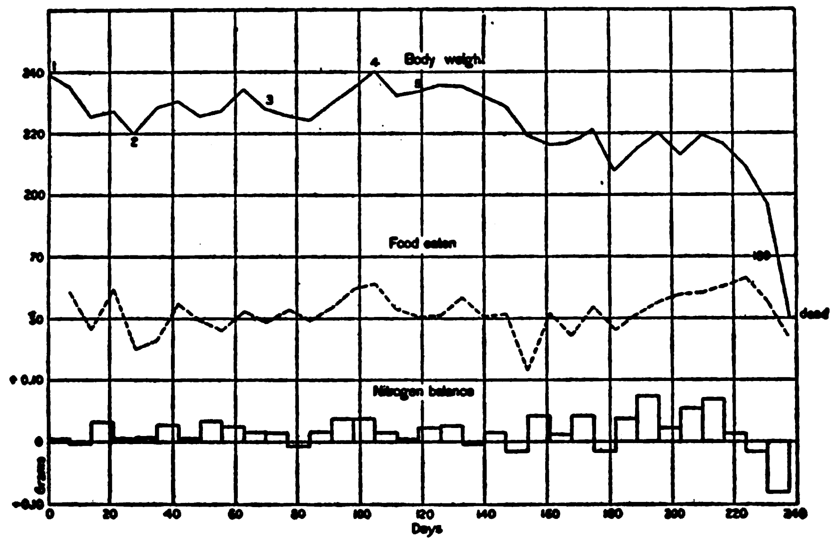


FIG. 4. (Taken from Carnegie Publication No. 156, page 45.) This rat was fed 210 days on a diet containing casein and excelsin as the only proteins.

component in the mixture that a defect ought soon to manifest itself—as indeed it did with zein. Nor did the animals fare better when more than one protein was present. Here, too, the ultimate decline in the grown rats inevitably showed up, as will be seen in the illustrative charts below.

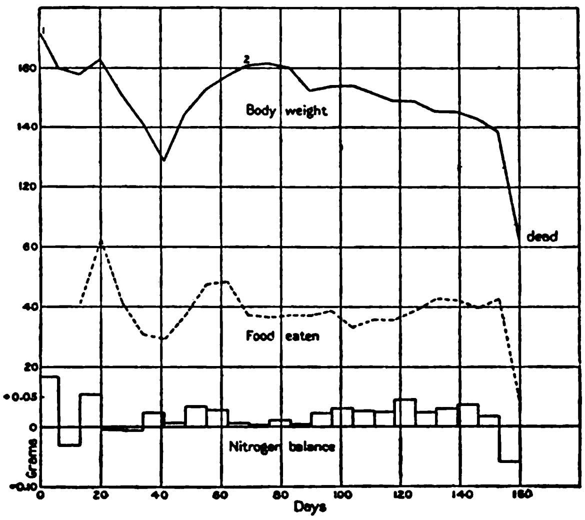


FIG. 5. (Taken from Carnegie Publication No. 156, page 46.) This rat was fed 160 days on a diet containing casein and pea legumin as the only proteins.

Remarkable in this connection were the observations made on small white rats during the period of active growth. Lacking food, at this stage, the animals speedily die, since the reserve stores are small or wanting. With an appropriate mixed diet growth is vigorous, and the rate of gain is strikingly similar in healthy animals of related origin. When young rats are fed on diets containing a single protein in the mixtures described above they *fail to grow,* although they can be maintained at uniform body weight and size for long periods. Here then is an evident distinction between *maintenance* and *growth* in respect to the function of the ration. An illustration of the stunting of animals in this manner is graphically afforded by the appended curves in which a dwarfed animal is compared with a suitably fed one from the same litter.

What is the factor or what are the causes connected with the ultimate failure of the older rats to thrive on the dietaries outlined, or of young rats to grow? Evidence which

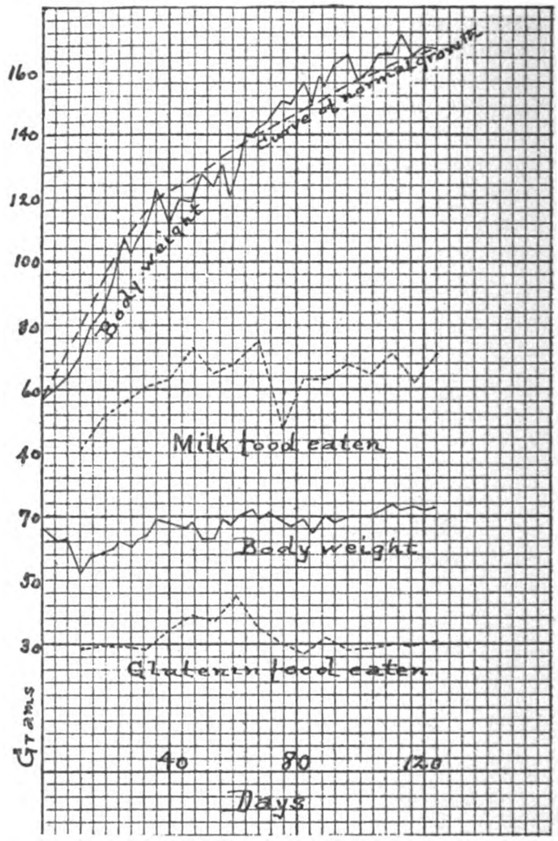


FIG. 6. Showing the body weight and food intake of a small rat grown normally on a diet of dried milk and lard in the upper curves. The lower curves are charted from a rat of the same litter maintained without growth on a diet containing glutenin as the sole protein in a mixture unsuitable for growth.

need not be reviewed here pointed to something other than the character of the protein, fat or carbohydrate. Animals will thrive and grow on a "mixed" diet of corn, vegetables, etc.; but we have, furthermore, noted that their nutritive needs can be met with an "artificial" food mixture in which dried milk and

fat form the sole ingredients.[11] That the stunted or malnourished rats in these earlier experiments have not lost their *capacity to grow* or, in the case of the adults, have not become permanently disorganized from a nutritive standpoint can be readily demonstrated; for they will resume growth or become realimented, as the case may be, as soon as mixed food is furnished. The milk mixtures are as efficient as mixed food in promoting growth and restoring nutritive equilibrium.

Rats have been carried through two generations on a food mixture of the following composition:

	Per Cent
Milk powder	60.0
Starch	15.7
Salt mixture	1.0
Lard	23.3
	100.0

Obviously the milk contains the nutrient elements essential to success which had previously not been satisfactorily imitated in the artificial food mixtures. It occurred to us to attempt to locate these as yet unknown components by removal of the proteins from milk and concentration of the protein-free (and fat-free) residues. The product thus obtained (and which may conveniently be termed "protein-free milk"[12]) has fulfilled our expectation and enabled us at length to study the relative value of added proteins in the dietary. The protein-free milk contains the milk sugar in addition to inorganic salts and other as yet unknown components of the milk. Whether

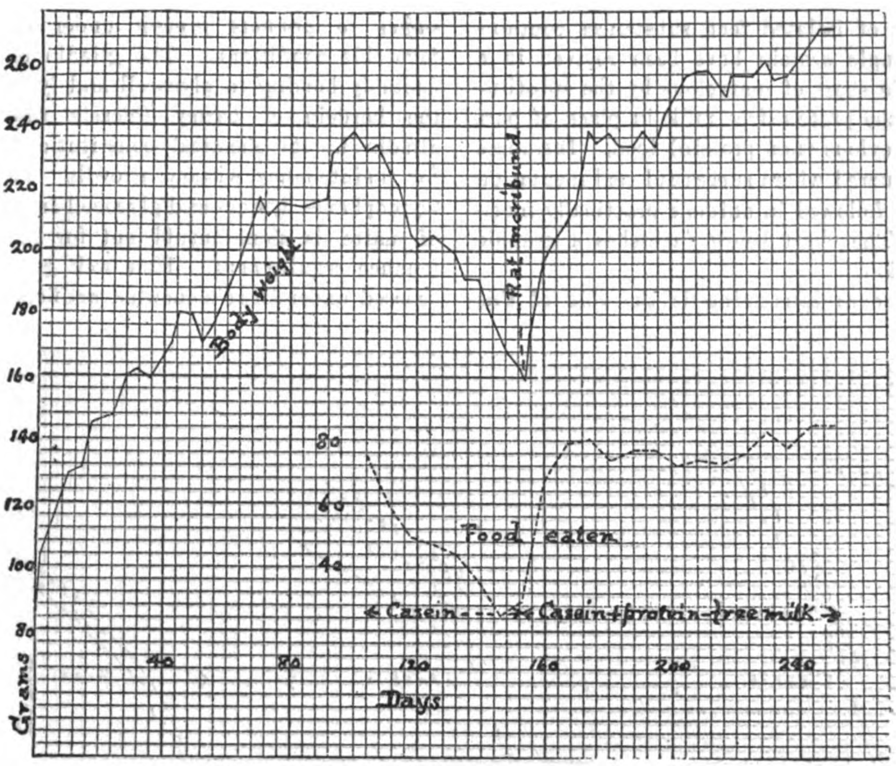


FIG. 7. Showing the realimentation of a rat practically moribund, by the addition of protein-free milk to the diet containing a single protein (casein).

[11] The dried milk used is the commercial "Trumilk," furnished by the Merrell-Soule Co., of Syracuse, N. Y.

[12] A detailed description of the preparation and composition of protein-free milk is given in the detailed papers, Part II.

it is the peculiar combinations of the latter, or some ideal "balancing" of the inorganic ions therein, or the presence of traces of essential organic compounds, or all of these, which guarantee the successful outcome, remains to be ascertained.

What has been accomplished thus far with the new possibilities of investigation at hand may be mentioned in brief. Rats which have developed marked symptoms of decline on mixtures of isolated food substances containing a single protein have been revived in a way little short of marvelous by the substitution of the protein-free milk in place of part of the previous (non-protein) food. Instances have occurred where successful realimentation has thus followed in animals practically moribund. The chart below furnishes a graphic illustration.

Even more interesting is the rôle of this protein-free milk in facilitating growth. By the use of protein-free milk to furnish the "accessory" portions of the diet the relative deportment of different proteins in growth has been investigated. Thus adequate growth has been noted where the sole protein was either the casein of milk, the lactalbumin of milk, crystallized egg albumin, crystallized edestin from hempseed, the glutenin of wheat, or glycinin from the soy bean. But *not all proteins suffice to promote growth* under otherwise favorable conditions. The gliadin of wheat (notably lacking in glycocoll and lysine) and the hordein of barley (closely resembling gliadin in its chemical constitution) suffice for maintenance without growth. Zein, the tryptophane-, lysine- and glycocoll-free protein of maize, is alone insufficient for the maintenance requirement. How well growth can proceed under these somewhat artificial condi-

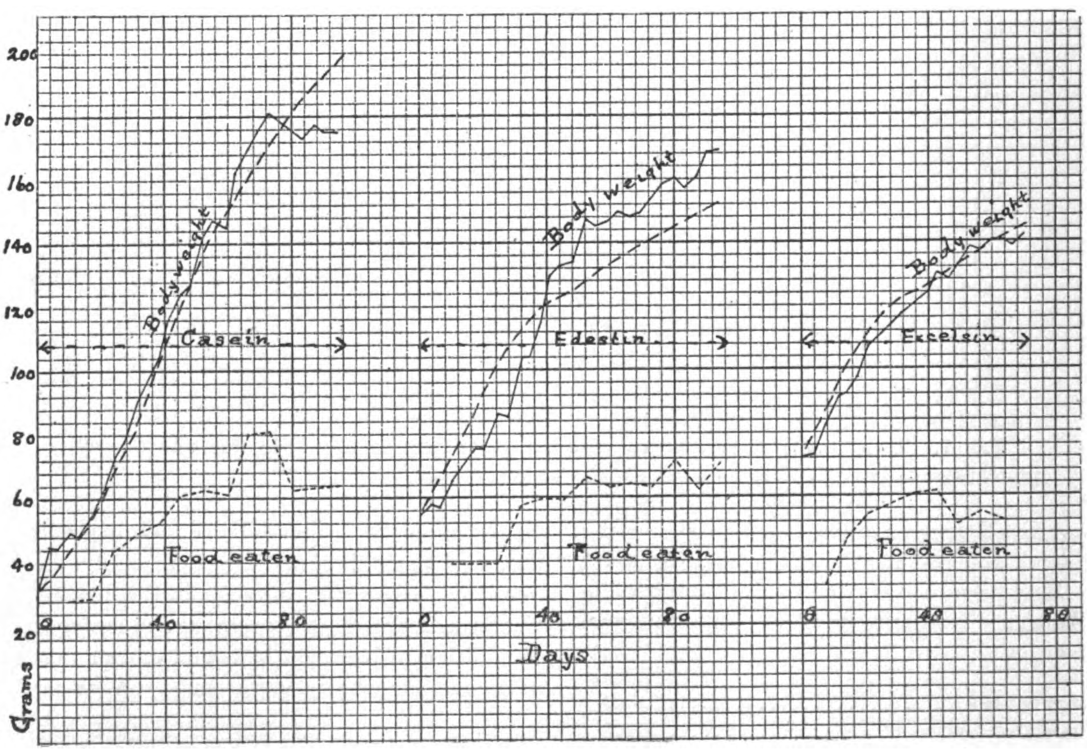
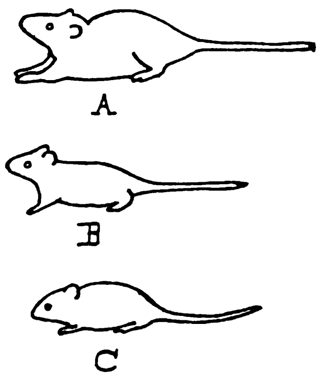


FIG. 8. Showing the growth curves of young rats fed on a diet containing a single protein together with protein-free milk. The upper broken lines in each figure indicate the normal rate of growth on mixed food.

tions of diet is shown in a few charts in which the curve of growth on mixed food is simultaneously plotted.

How entirely different the results are when an "inadequate" protein is alone furnished, despite an abundant ingestion of food, is strikingly shown by the drawings. The animals *A* and *B* were of one age and differed simply in having been sustained on different proteins.



This drawing shows the influence of different proteins on growth. *A* and *B* are rats of the same brood which were fed from the time of weaning on foods of the same composition except that the diet given to *A* contained pure *casein* while that given to *B* contained pure *gliadin* as its only protein. The appearance of *B* at the age of 140 days closely resembles that of *C*, a normally nourished rat, which at the age of 36 days had the same weight as *B*. (Sketch from photographs in Publication 156, Part II., Carnegie Institution of Washington, 1911.)

It will be noted that the older but stunted animals do not vary materially in size from properly nourished younger animals which have attained the same body weight. Herein they differ essentially from young animals which, maintained at constant body weight by underfeeding, continue to grow in size. Such conditions have been described in cattle,[19] dogs[20] and children;[21] and they lead to disproportioned forms. Our (malnourished rather than undernourished) rats have merely maintained themselves, if we except the possibility of a continued development of the nervous system of which we have furnished some evidence elsewhere.[22]

Aside from the nutritive inequalities of different proteins, as well as the apparent comparable suitability of chemically and biologically unlike proteins—all of which remains to be subjected to more refined experimental investigation—it is worth while to point out numerous other incidental findings. Animals which have grown from small size, *e. g.*, 40 grams, to adult form, *e. g.*, 160 grams, and have thus quadrupled their weight on a diet furnishing its nitrogen in the form of a simple protein like edestin, have by some process perfected the synthesis of purines and nucleoproteins, perchance of phosphoproteins and nitrogenous phosphatides, and of ferruginous proteins (like hemoglobin) from iron-free protein precursors and "inorganic iron."

With what powers of synthesis in such directions is the body provided by nature? What modifications, if any, can be introduced into the organism in respect to structure, function or inheritance by the possibility of a successfully regulated control of the character of the most important foodstuff, the protein? Such physiological and broader biological questions appear to lend themselves to experimental study by the methods which we have initiated. There are, further, pathological aspects involving abnormal growth, dwarfism, recuperation and senescence which similarly suggest themselves. The program for the future is limited only by the success and efficiency of the methods adopted.

To the biological chemist, no feature of these problems appeals more strongly, perhaps, than the question of how an organism can build such diverse nitrogenous tissues from a

[19] Waters, *Proceedings Society for the Promotion of Agricultural Science*, 1908, XXIX., p. 3; also *Ibid.*, XXX., p. 71.

[20] Aron, *Biochemische Zeitschrift*, 1910, XXX., p. 207; *Philippine Journal of Science*, Sec. B., 1911, VI., p. 1.

[21] Fleischner, *Archives of Pediatrics*, October, 1906.

[22] Osborne and Mendel, Carnegie Institution of Washington, Publication 156, Part II.

single dietary protein. It is true that the newer conceptions of the extensive rôle of hydrolysis in digestion prior to absorption have extended the inquiry a step further, so that we may ask what is the minimum of this or that amino-acid or simple polypeptide required. But we have seen rats grow for months with casein—thoroughly purified and glycocoll-free—as the sole source of these amino-acids. During this time, one animal even brought forth two broods of young and secreted milk in sufficient quantity to bring her young to the age when they were able to care for themselves. Another pair of rats maintained 178 days on gliadin as the sole protein of the diet produced healthy young and successfully reared them. It is most unlikely from all that is otherwise known, that the tissues of our experimental animals are chemically imperfect or essentially unlike those of normally fed rats which presumably do contain glycocoll and lysine groups. Have we heretofore underrated the ultimate synthetic capacities of animal cells?[33]

The observation that animals long maintained on diets of the character used in our feeding trials voraciously eat the feces of normally fed rats led us to experiment in another direction. It has been noted as a result of this that in a not inconsiderable number of instances the feeding of small portions of "normal" rat feces tended to check the decline of rats kept on pastes of isolated food substances containing the earlier salt mixture. The possibility of altering the bacterial flora of the alimentary tract by dietetic conditions at once suggests itself in this connection, and reference may be made to the significant studies of Herter and Kendall,[34] among others, which elucidate this question. To what extent is the cooperation of bacteria either essential or useful in the alimentary functions? This is, indeed, still a debated question.[35] But one can not dispel the idea that bacteria might, after all, enter into reconstructive reactions which may furnish new nitrogenous complexes from amino-acids. Viewed in this light, the immediate hydrolysis products of our foodstuffs may become available only after they have in greater or less part been reconstructed by the preeminently synthetic symbiotic bacteria into products of more uniform character, possibly widely different from the original intake. Nucleoprotein synthesis, for example, may thus become referable to bacterial intervention; and the subtle influence of the indeterminable non-protein factors may lie in some measure in the regulation which they exert upon the microorganisms of the gastro-intestinal tract.[36] In any event such suggestions need to be dealt with.

It is hoped to continue these nutrition studies, the possible scope of which has barely been indicated in what has gone before. They seem to us to justify the effort which has been involved. Indeed only by unremitting regard for details, such as the careful purification and preparation of the materials fed and attention to the animals, can the uncertain factors be limited, comparable results obtained and definite conclusions safely drawn. We realize that only a beginning has been made, and believe that further progress is possible.

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[33] One is reminded of the recent studies of Knoop, *Zeitschrift für physiologische Chemie*, 1910, LXVII., p. 489, and Embden and Schmitz, *Biochemische Zeitschrift*, 1910, XXIX, p. 423, bearing on such possibilities. Cf. Mendel, *Ergebnisse der Physiologie*, 1912, XI.

[34] Herter, "The Common Bacterial Infections of the Digestive Tract," The Macmillan Co.; Herter and Kendall, *Journal of Biological Chemistry*, 1910, VII., p. 203; Kendall, *Journal of the American Medical Association*, April 15, 1911.

[35] Nuttall and Thierfelder, *Zeitschrift für physiologische Chemie*, 1895, XXI., p. 109; Schottelius, *Archiv für Hygiene*, 1908, 67, pp. 177–208.

[36] Cf. Armsby, "The Nutritive Value of the Non-protein of Feeding Stuffs," Bureau of Animal Industry, Bulletin 139, 1911.

SCIENCE

Friday, December 1, 1911

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

INAUGURAL ADDRESS OF THE PRESIDENT OF THE UNIVERSITY OF MINNESOTA[1]

The ceremonies of this hour mark not so much the coming of a man as the beginning of a new phase in the life of the university. In the sweep of time most men are merged in the on-going human tide. It is wise, therefore, to look beneath the formal and the personal; to ask what this occasion really means or what it ought to mean.

Of one thing there can be no doubt. This day sees the passing of a personal leadership, although happily not the waning of that personal influence. Not all mortals are destined to be engulfed in the nameless millions of mankind. A few outstanding men can not be forgotten. "An institution," said Emerson, "is but the lengthening shadow of one man." Minnesota, in this sense, will be the lengthening shadow of Cyrus Northrop. Such unity as the university has found is due almost wholly to the fusing power of his winning and guiding personality. The university stands a living tribute to the quick sympathy, humorous tolerance, harmonizing tact, alert intelligence and moral earnestness of its president emeritus. He had to convince an often skeptical outside public; he had to moderate and adjust keen rivalries within the institution. Colleges and departments sought their own ends with only a faint glimpse of the university as a whole. As he lays down the burden of twenty-seven years he leaves the institution firmly grounded in the good will of the people, and unified by the loyalty of faculty, alumni and students. We should

[1] From the *Minnesota Alumni Weekly*.

sadly miss the meaning of this day did we fail to turn our grateful thoughts toward Cyrus Northrop and to wish him many years of serenity and happiness. Unlike Macbeth, he has

> . . . that which should accompany old age,
> As honor, love, obedience, troops of friends.

To-day the university sets its face toward a new regime. No man can take the unique place of its second president. The burden must rest on many men and women, who, as comrades, take up the task. The gains of the personal ascendency that has passed must be capitalized. Cooperation, organization, team-play, are keynotes for the coming years. An institutional period is at hand. Loyalty must look to purposes rather than to a person. Leadership will consist in carrying out policies which many have helped to formulate. Regents, faculties, alumni, students—all citizens, must see the institution more vividly as a noble trust to be administered for the common good. This spirit of cooperation can be aroused only by a compelling vision of the university seen as an organ of the higher life of the commonwealth. And this ideal must get its setting in some inspiring philosophy of the state.

Mr. H. G. Wells tells us that we, as a nation, suffer from "state blindness." "The typical American," he says, "has no 'sense of the state.' I do not mean that he is not passionately and vigorously patriotic. But I mean that he has no conception that his business activities, his private employments, are constituents in a large collective process; that they affect other people and the world forever, and can not, as he imagines, begin and end with him."

Even our friendly critic, the British ambassador, takes much the same view. "The state," declares Mr. Bryce, "is not to them (Americans), as to Germans or Frenchmen, and even to some English thinkers, an ideal moral power, charged with the duty of forming the characters and guiding the lives of its subjects. It is more like a commercial company, or, perhaps, a huge municipality created for the management of certain business in which all who reside within its bounds are interested. . . ." This individualistic, "stock company" theory of the commonwealth is neither ennobling in itself nor does it afford a sound basis for a state-supported university. We may paraphrase Mr. Joseph Chamberlin on the British Constitution, and thank God that our institutions are not logical. This philosophy would almost reduce the university to a machine for turning out persons equipped at public expense for getting a living out of the citizens who had been already taxed to train their exploiters. On this basis it is hard to see why the state should give privileges to a few at the expense of their fellows. Even the "antidote against ignorance" philosophy leaves the imagination cold. This is only a sublimated form of the policeman theory. Obviously we need some other conception of the state if we are to escape cynicism about both our social system and our public higher education.

But we can not admit that Mr. Wells and Mr. Bryce have quite made out their case. There are signs of change in the feeling of Americans toward the state. Especially in the middle and the far west do we note a keener recognition of collective interests and purposes. There is a quickened feeling of team-play, a clearer "sense of the state," which is thought of not in a merely political way, but is looked at as a social life with common aims. The people of a state have learned to work together to protect natural resources, to foster agriculture, to safeguard public health, to regulate industry and commerce, to improve the highways, to care for the defective and de-

pendent, to promote education. They have done these things sometimes through the machinery of government, sometimes through unofficial groups. All this community activity has inevitably changed the picture of the state in the minds of its citizens. The commonwealth emerges as something far nobler than a stock company run for the profit of its shareholders. It does become "an ideal moral power," a larger life in which men and women realize more fully their best selves, and to which they give something that will endure for all time. The state is coming to stand for a common life which seeks to gain ever higher levels of efficiency, justice, happiness and solidarity.

In a picture like this the state university finds both setting and sanction. It becomes an instrument of the general purpose, a training place of social servants, a counsellor of the commonwealth, a source of knowledge and idealism. It is this vision which must fascinate and control the men and women who are to-day taking up anew the responsibility for this institution. Arnold Toynbee once said: "Enthusiasm can only be aroused by two things, first, an ideal which takes the imagination by storm, and second, a definite, intelligible plan for carrying this ideal out into practice." Here is the whole philosophy of successful effort. Many an ideal comes to naught because it lacks the right means of expression. Many a well-laid plan misses the emotional energy aroused by a vision. Emerson's Oxford don whose philosophy read: "Nothing new, nothing true, and no matter" was not of those who bring things to pass. We do well to-day to catch a glimpse if we can of the university that ought to be, with the hope that it may "take our imaginations by storm" and urge us to devise "definite and intelligible" plans for action.

Francis Bacon had a dream to which we turn for a moment. In his "New Atlantis" he pictured an ideal commonwealth organized about a Solomon's House or "College of the Seven Days Works." This college "sought the knowledge of causes and secret motions of things, the enlargement of the bounds of human empire to the effecting of all things possible." The equipment of the college was complete. There were caves and mines for the study of metals, minerals and cements; towers for celestial observations; lakes for the breeding of fish; animal houses for biological experiment; orchards and gardens in which the wonders of Burbank were anticipated; parks for studying beasts and birds; kitchens for making predigested foods and health-giving drinks; operating rooms in which animal vivisection threw light on human diseases; dispensaries for medicine; laboratories for physical experiments; shops where flying machines and submarines were made; collections of minerals; sound houses, mathematical laboratories, and even a "house of the deceit of the senses" in which wonders were first wrought and then explained to a bewildered public.

But more important than the equipment was the staff. The "College of the Seven Days Works" was dedicated to research. Twelve "merchants of light" traveled the world over in search of books, apparatus, and all the latest discoveries. Three men collated these materials. Three others verified all reported experiments. Still another three known as "pioneers" or "miners" undertook new investigations, the results of which were passed on to three compilors. All discoveries that had practical utility were applied to daily life by "dowry men" or "benefactors." Not yet content, the college pushed its researches further. Three "lamps" as they

were happily called—"search-lights would be the word to-day"—projected still more penetrating inquiries which were carried out by expert "inoculators." The last step was taken by the "interpreters of nature," who sought to translate into terms of human happiness and destiny all the knowledge that their colleagues had discovered. Moreover, the "College of the Seven Days Works" did not rest content with finding truth. It put this at the service of all citizens. Were it not for its quaint form this passage might have been taken from the announcements of one of our own universities:

"Lastly we have circuits or visits of divers cities of the kingdom; where, as it cometh to pass, we do publish such new, profitable inventions as we think good, and do also declare natural divinations of diseases, plagues, swarms of hurtful creatures, scarcity, tempests, earthquakes, great inundations, comets, temperature of the air, and divers other things; and we give counsel thereupon, what the people shall do for the prevention and remedy of them."

Thus, early in the seventeenth century, we have a foreshadowing of the essential ideals of the modern university—equipment for investigation and instruction in every field of human knowledge, a staff trained and set apart as a priesthood of truth, giving themselves devotedly to their high calling, and finally a wide diffusion to all citizens of the knowledge, skill and idealism of which the university is a center and a source. We are only beginning, however, to see the need for a more effective and economical organization of research. This dream of Bacon's made more democratic, widened in scope and spirit, is yet the same as that of Huxley, who believed that universities "should be places in which thought is free from all fetters and in which all sources of knowledge and all aids to learning should be accessible to all comers without distinction of creed, or country, riches or poverty."

Let us glance rapidly at the chief things that combine in the university ideal which we would fix in our minds to-day. If the phrase "glittering generalities" dampens our ardor, we may take courage from Emerson's spirited retort, when Choate applied these words to the lines of the Declaration of Independence. "Glittering generalities!" cried the Sage of Concord, "they are blazing ubiquities!"

The picture of the state as a collective life, which seeks common ends by concerted effort, makes the state university a means of social efficiency and progress. The older individualistic theory no longer satisfies even those who put their faith in private initiative and responsibility. The university aims first of all to serve the commonwealth through individuals, not to offer personal privilege at state expense. Alma Mater is of a Spartan type, and trains her sons and daughters for work and for life. She must teach the robust gospel that "It is the one base thing to receive and not to give." She must insist that "Life is not a cup to be drained, but a measure to be filled." For the old aristocratic ideal of *noblesse oblige* she substitutes the sentiment *largesse oblige*. Acceptance of public aid may make a pauper or an ingrate or a loyal servant of the state. If tax-supported higher education is to be justified it must see itself and make the people see it as an instrument of the common life, and not an agency of privilege.

The first president of Johns Hopkins University was fond of saying that buildings are but the shell of the university; its real life lies in its men. He was proud of the fact that at the very outset an eminent physicist like Rowland used a kitchen as his laboratory. Only great men and wo-

men can make a university great. Better inspired investigators and teachers in barracks than a staff of industrious mediocrity in marble palaces. Best of all, alert, well-trained, high-minded scholars in serviceable buildings with adequate equipment. If, however, a choice must be made, it should never hesitate between men and materials. The university which is true to its ideals will draw and hold an able staff by salaries that banish petty anxiety, by freedom from drudgery, by opportunities for research and public service, and by dignifying recognition. No institution that thinks of investigators and teachers as employees is likely to secure any but the drudges of the profession.

"Enthusiasm for truth, that fanaticism of veracity," which Huxley deemed "a greater possession than much learning" is the very life of a true university. No modern "College of the Seven Days Works" can hope to keep itself alive and fruitful unless some of its members are ceaselessly engaged upon the unsolved problems. No ingenious machinery of scholarship, no mere pedantry which, as a wit has said, "never takes a step without leaving a footnote," can take the place of the genuine passion for new truth. The ideal university will not deceive itself or others by any perfunctory simulation of research. It will seek men who have the dauntless "fanaticism of veracity."

"The teaching at the ideal university," declares Birrell, "is without equivocation and without compromise. Its notes are zeal, accuracy, fullness and authority." It is hard to keep the functions of teaching and investigation in equal honor. Where research is exalted instruction is too often lightly esteemed. The "mere teacher" as the patronizing phrase runs, suffers in rank and salary and social status. In the university of our dreams the noble calling of imparting truth, stimulating reflection and kindling enthusiasm will be held in high repute. But the two types will not be too sharply contrasted, for he who teaches "with zeal, accuracy, fullness and authority" must refresh himself constantly at the sources of knowledge, while no man who pushes forward the frontiers of science can fail to impart with zest to at least a small group of followers the new truth that he has discovered. The two types must hold each other in respect and honor, and both must be held up for admiration by their colleagues.

In an ideal university students should be treated not as subjects, but as citizens of the republic of letters and science. Students have not always been in pupilage. Frederick Barbarossa conferred such powers upon the students of Bologna that they not only lorded it over the towns-folk, but we are told "reduced the latter (professors) to a position of humble deference to the very body they were called upon to instruct." To admit students to academic citizenship, however, is not to surrender to them control of the university. It is simply to emphasize their share in the community life; to fix upon them responsibility and to afford that training in corporate self-control—the selection of leaders, the creation of standards, the conformity to these—which is the very essence of democracy. The university must hark back to the mediæval ideal of a "Universitas magistrorum et studentium"—a corporation of teachers and scholars. The alumni, too, must feel themselves a part of this corporation. They do not, as at the English universities, legally control, but actually they have great power and responsibility. They will not be mere praisers of the past, and resent change because the memories of their undergraduate days have been embalmed in sentiment. On the con-

trary they will often take the initiative in new movements. They will report impressions gathered as they mingle with the people of the state; they will feel not only free, but in duty bound to make suggestions; they will make it a point to know what the university is aiming at, and will help to interpret the institution to the state. The alumni will frequent the only lobbies that the university can afford to enter, the daily converse of citizens and the agencies of publicity. And all this the alumni can do effectively only through an organization which will cooperate heartily with the other members of the university community.

If a people is not to perish mentally and spiritually it must be steadily refreshed by streams of thought and idealism. Of these the university strives to be a perennial source. Unless graduation is a mockery hundreds of men and women go forth each year to diffuse throughout the commonwealth the ideas and attitude toward life which they gained from their college training. The value of all this must be as real as it is intangible. Mathew Arnold has described the effect of such diffusion of ideas in speaking of "this knowledge turning a stream of fresh and free thought upon our stock notions and habits, which we now follow staunchly but mechanically, vainly imagining that there is a virtue in following them staunchly which makes up for the mischief of following them mechanically." If a state is to be flexible and escape the bonds of habit and custom it must be constantly revivified. In this service the university must play a leading part.

The university campus must be as wide as the boundaries of the commonwealth. The term university extension comes to us from the aristocratic centers of Cambridge and Oxford. There is about it a faint suggestion of the missionary spirit—just a hint of patronage and condescension. Of this spirit there must be no trace in a state university. Where truth is to be discovered or applied, wherever earnest citizens need organized knowledge and tested skill, there the university is on its own ground. Our ideas of time and space are changing rapidly; traditional prejudices are disappearing. The university sees as its members not only the students who resort to the chief center, but the other thousands on farms, in factories, in offices, in shops, in schoolrooms and in homes who look to it for guidance and encouragement. It is fascinating to picture the possibilities of this widening sphere of higher education as it makes its way into every corner of the state, frankly creating new needs and resourcefully meeting the consequent demands.

To find exceptional men and women, to train them for service, to fit them for leadership, to fill them with zeal for truth and justice, is the one great aim of the university. "The mind which keeps the mass in motion," said Godkin, "would most probably, if we could lay bare the secret of national vigor, be found in the possession of a very small proportion of the people, though not in any class in particular, neither among the rich nor the poor, the learned nor the simple, capitalists nor laborers. . . ." Society must see to it that this vivifying mind comes to its own. Aristocracy draws its leadership from a caste; democracy from every group of the people. The state university should be accessible to all who give unusual promise, whether they have private means or not. Cecil Rhodes left a fortune to make Oxford for all time a Mecca for successive scores of American youth. Surely, large-minded men of wealth, local communities, some time, perhaps the state itself, will endow scholarships which will draw to our uni-

versities exceptional young men and women from every county of the commonwealth. This would be a statesman-like, far-seeing thing to do. The experience of Scotland and England for three centuries has its lesson. The hardy north has contributed to the United Kingdom men well beyond its per capita quota. This outstripping of England is to be credited largely to the democratic education of Scotland in contrast with the caste system of England. Huxley in an address at Aberdeen, thus pictures the two types: After speaking in tolerant vein of "The host of pleasant, manly, well-bred young gentlemen who do a little learning and much boating by Cam and Isis," he goes on to say, "when I turn from this picture to the no less real vision of many a brave and frugal Scotch boy spending his summer in hard manual labor that he may have the privilege of wending his way in autumn to this university with a bag of oatmeal, ten pounds in his pocket and his own stout heart to depend on through the northern winter; not bent on seeking

'the bubble reputation at the cannon's mouth,'

but determined to wring knowledge from the hard hands of penury; when I see him win through all such outward obstacles to positions of wide usefulness and well-earned fame, I can not but think that in essence Aberdeen has departed but little from the primitive intentions of the founders of universities." The individual side of the picture has its appeal, but its social aspect is after all more significant. From the university towers the search-lights must be ever sweeping country-side, village, town and city for the "minds which keep the mass in motion."

Standards of truth, skill, taste, efficiency are the capitalized experience of society, essential to stability and progress. Of these standards the university is one of the guardians. To these, come what may, it must be true. No sympathy for individuals, no pressure of influence, no fear of retaliation, no desire for numbers must weaken fidelity to standards. Freedom of research, freedom of teaching, high ideals of productive scholarship and of professional integrity, conscientious and fearless appraisal of students' work are of vital concern to the university and to the state it serves. To help to refine and raise these standards, to adjust them more nicely to social needs, to fix these values in public opinion, is a duty of the ideal university.

In the striking phrase of President Van Hise, the university must aim at being the "expert adviser of the state." How stirring the thought of a well organized and efficiently manned center of knowledge, skill and wisdom, holding itself at the disposal of every constructive interest and activity of the community, and ready to concentrate upon their problems the sifted experience of all the world. In this responsiveness the true university expresses its purpose and spirit. It is a bureau of information, the stored memory of civilization, an alert investigator of new facts; it is a friendly and at the same time a disinterested counsellor. It is pathetic to see men, isolated from the wisdom of the centuries and of their own times, hopefully assailing the ever recurring problems of life. The waste of effort, the futility of duplicating errors, cry out for aid. The opportunities for service multiply with each year. We are coming to realize that good farming is no longer a robbing, but a recompensing of the soil; that it costs as much to plant bad seed as good; that sometimes cows are pensioners instead of producers; that bad highways are the heaviest road tax; that cheap schools are the most expensive; that public health is

national capital; that juvenile delinquency comes less from depravity than from deprivation; that industrial accidents are not lawyers' perquisites, but costs of production; that all idleness is not due to indolence; that social legislation is not an amiable avocation, but an exacting profession; that municipal government should not be so skilfully designed to prevent bad men from doing harm, that it keeps honest and efficient men from doing good; that the United States must trust less to a "manifest destiny" and more to a constructive purpose. In these changes of theory and method there is need of accurate knowledge, carefully interpreted experiment and authoritative advice. If the university is true to its mission it will put all of its resources and its trained experts at the service of the community. Amid the conflicts and rivalries of many interests, parties, sects, sections, professions, social groups, the university must never waver from the position of an unimpassioned, unprejudiced seeker for the truth, all of it and that alone. This responsibility is not to be assumed lightly. Mistakes are costly in public confidence. Eternal vigilance is the price of prestige. The discomfiture of the expert gives joy to the average citizen. The ideal university must, therefore, be true to the most rigorous laws of scientific method if the institution is to gain and hold its place as the "expert adviser of the state."

By virtue of its rôle as a public servant the university is under peculiar obligation to cooperate with all the other agencies of the state, its commissions, boards and institutions. These should turn naturally to the university for expert advice and for trained functionaries. So, too, the many private associations, charity organization societies, playground associations, social settlements, juvenile protective leagues, public art societies, study clubs, and other similar groups should find the university ready to meet them more than half way. With the educational forces of the state the university should be in close terms of sympathy and effective team-play. The elementary schools are not to be deemed beneath the notice of higher education. On the contrary, the university should be a leader in studying painstakingly the problems of the common schools. It can not afford to be indifferent to the broad base of the educational pyramid. That the university is vitally interested in the high schools says itself. Yet this interest must not take the form of either patronage or dictation. The days for these things have passed. With the high schools in charge of college-bred men and women condescension is intolerable. Since the high school, in the west at least, is recognized as the "people's college," to assign it to the rôle of an obedient preparatory school is out of the question. Nevertheless, the high school needs the university as a friend and counsellor. The relations between the high schools and the university should become closer through the association of all that are interested in the same subjects of instruction, by periodic conferences at the university, by visits not only of college teachers to high schools, but of high school instructors to college class-rooms, by joint committees which shall study the educational system as a whole. To the normal schools the university has held an anomalous relation. These institutions were founded to prepare teachers for the common schools. Of late college training has become virtually a prerequisite for high school appointments. The normal schools have been attended by growing numbers who expect to go on to college. At the same time the demand for training in the natural sciences, modern psychology, in-

dustrial arts, home economics (just now agriculture is seeking admission), has compelled the schools to widen their curricula and strengthen their teaching force. In these circumstances the idea of some readjustment inevitably arises. The university is in duty bound to confer with the normal schools and to seek a wise solution for the problem. So, too, with the private colleges of the state, the university must be on the friendliest terms. Close relations between these colleges and the professional schools of the university should be established, so that there may be no semblance of compulsion as to the place of collegiate preparation. The true unity of the state educational system consists not in official machinery, but in a spirit of mutual understanding, respect and good will among the men and women to whom the educational interests of the state are entrusted.

The spirit of cooperation is more palpable than another influence which should radiate from the university. And that is the scientific spirit. This is an attitude of open-mindedness toward all truth, a determination to get all the essential facts before forming a judgment, a willingness to abandon a position when it is no longer intellectually tenable; a tolerance for the opinions of others which are to be accounted for rather than derided or denounced. This spirit is free from acrimony, blind partisanship and prejudice. In a world of eager activity, of personal ambition, of keen group rivalry, of clashing interests, with all the consequent bitterness and misrepresentation, it is the duty of the university both in its methods and in its personnel to set a shining example of that calm, fair-minded, tolerant spirit that seeks the truth which makes men free.

"The benefits the country derives from the university," wrote Mr. Godkin thirty years ago, "consist mainly in the refining and elevating influences they create, in the taste for study and research which they diffuse, in the social and political ideals which they frame and hold up for admiration, in the confidence in the power of knowledge which they indirectly spread among the people, and in the small though steady contribution which they make to the reverence for 'things not seen' in which the soul of the state may be said to lie and without which it is nothing better than a factory or an insurance company." There is no mention in all this of direct utility through professional training or industrial efficiency. The editor of the *Nation* would, perhaps, have repudiated these things as Mr. Birrell did in an address he gave to a body of London students. "The education it (the university) essays to give will not teach you to outgabble your neighbor in the law courts, to unseat him in his constituency or undersell him in the market-place. Gentlemen, be it understood once for all, those things do not require a university education. The commonwealth may safely leave these to be performed by the combination of the three primary forces, ambition, necessity and greed." Of our own Cornell University in its early years the author of "Culture and Anarchy" wrote: It "seems to rest on a misconception of what culture truly is, and to be calculated to produce miners, or engineers, or architects, not sweetness and light." Here are pertinent questions. Can the state safely leave to "ambition, necessity and greed" the training of its professional men and its leaders? Has it no place for culture, for what Arnold read into Swift's phrase "sweetness and light"? In its eagerness for valuable knowledge and practical efficiency is the university neglecting "the things that are more excellent"? Is it losing reverence for "things unseen"? Of this there is always

danger. Action and tangible results that appeal to men so strongly are often at odds with reflection and spiritual values. The ideal university must not forget that material efficiency is only a means to ends—a finer type of personality, a more just and ennobling social order. The university aims at training, not skilled exploiters, but men and women who shall first of all be high-minded citizens with a loyal "sense of the state," who shall exemplify the scientific spirit, bear themselves gallantly in life's struggles, show themselves possessed of satisfying mental resources, and prove faithful to the highest standards.

Men and women of this sort do not issue from a place given over wholly to utility and material interests. There must be a controlling, pervasive spirit of service, a desire for "a harmonious expansion for *all* the powers which make the beauty and worth of human nature," and a real appreciation of life's deeper meaning. The university must help men to answer Kant's three questions, the questions of science, of morality, and of religion: "What can I do? What ought I to do? What may I hope for?" True, the state university can have no official theology and no ecclesiastical affiliations. But it may have a spirit of reverence for the mysteries of life; it may cultivate that essential religion which exalts the things of the human mind and spirit over things physical and which reads back of the material world a purpose and a destiny. "The state," said Arnold, "is of the religion of all of its citizens, without the fanaticism of any of them." Bacon's "College of the Seven Days Works" was a research institution, but it did not forget that it was concerned with only certain aspects of a vast university. "We have," said one of the staff, "hymns and services of laud and thanks to God for His marvelous works, and forms of prayer imploring His aid and blessing for the illumination of our labors and the turning of them unto good and holy uses."

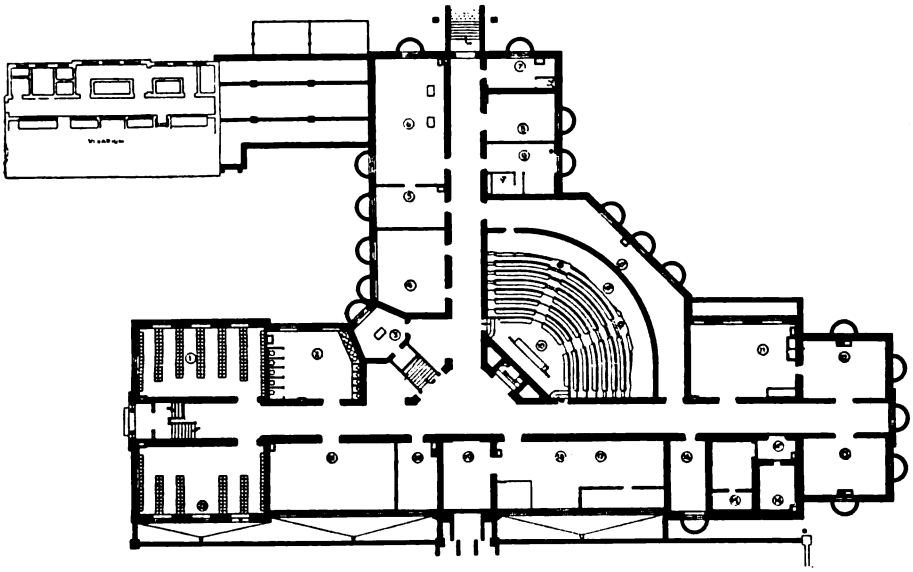
We have caught glimpses of the university ideal. May this, as the years pass, grow ever clearer, nobler, more inspiring. May it take our "imaginations by storm" not as an evanescent emotion, but as a persistent vision. We remember Toynbee's words, "a definite intelligible plan for carrying that ideal out into practise." It is to the many details of this plan that as colleagues we are to address ourselves. May we take up this great task with a solemn sense of what it means. We must not deceive ourselves. We advance to no easy triumphs. We must cherish no millenial dreams. We must have faith that good-will guided by wisdom will in the end bring our vision to pass. Let us then with sober judgment and steady courage pledge anew our loyalty to the ideals of the university, to the people of the state and to that republic of science, letters and the arts which knows no national boundaries. May each of us take to heart the counsel of Goethe:

> What each day needs, that shalt thou ask;
> Each day will set its proper task.
> Give others' work just share of praise;
> Not of thine own the merits raise;
> Beware no fellow man thou hate;
> And so in God's hands leave thy fate.

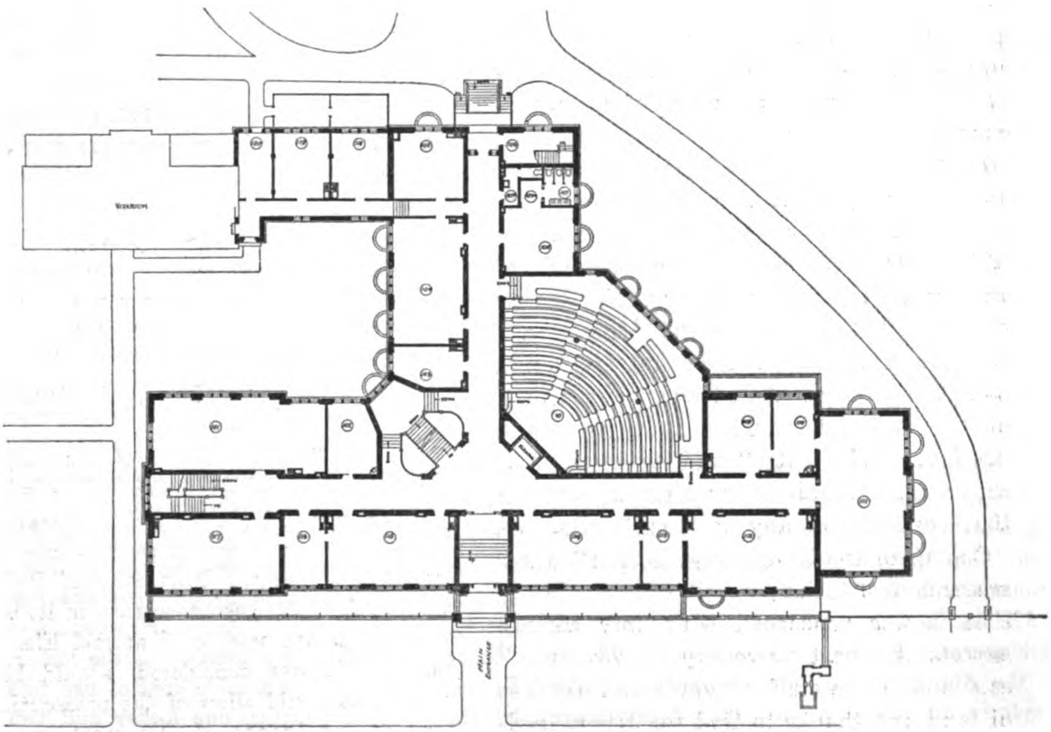
GEORGE E. VINCENT

THE NEW ZOOLOGICAL LABORATORY OF THE UNIVERSITY OF PENNSYLVANIA

IN devising and planning this laboratory to fill the needs for many years to come of zoological study at the University of Pennsylvania, zoology has been construed in its broadest sense, as the science of animal life. All, therefore, it was considered, should be included that would allow of the prosecution of study in any branch of this great and most important subject; and this object we have



Basement



The First Floor

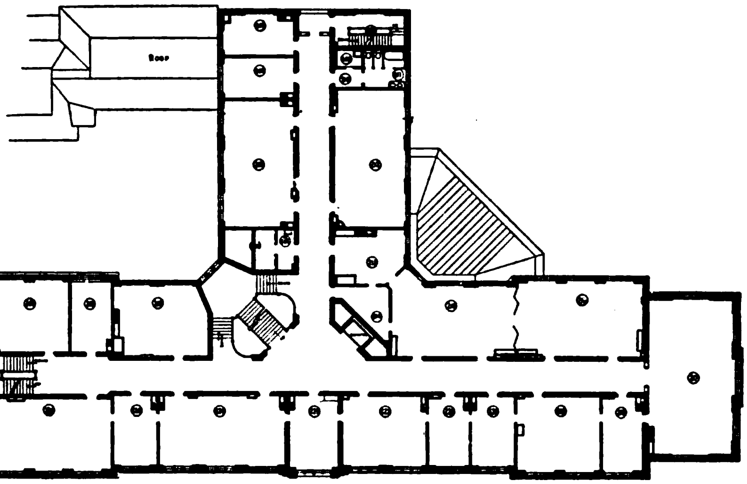
tried to fulfill, so far as we understand present needs and could foresee future ones. Great praise is due to the architects, Messrs. Cope and Stewardson, for aiming at utility first, and for meeting as closely as possible the requirements planned by the staff.

The building comprises a full basement, with three stories above it, and is thoroughly fire-proof. The general form is that of a T, the longest wing facing north with a length of 216 feet. The shorter south wing connects at the east with the vivarium building that was erected in 1900. This gives a minimal amount of hall space and all corridors, even those of the basement, are amply lighted by windows at their ends and by glass interior doors. The main entrance is in the center of the north façade, and close to this main entrance is the main stairway. There is a second entrance and stairway at the east end of the main wing, a special freight entrance to the basement at the south end, and near the last an exterior fire escape. The type of architecture is early English Renaissance; the walls are of sand-moulded red brick, in a variety of shades, laid Flemish bond. Base courses, cornices and window-sill levels are of gray Indiana limestone; the corners of the building are built of this stone, and doorways and windows framed with it. All windows are exceptionally large and extend nearly to the ceilings; those on the north front have in each sash two panes of glass separated by a half-inch air space, so as to reduce the cost of heating.

Above the third-story windows of the east end of the main wing are inscribed the names of Cope and Leidy, the great naturalists of Philadelphia; and on its north face the names of Lamarck, Darwin, Huxley, Claude Bernard, Johannes Mueller, Harvey, Aristotle, Malpighi, Von Baer, Schwann, Réaumur, Cuvier, Linnæus and Ray.

All floorings are cement; this is covered with terrazza in the corridors, with linoleum in the library and lecture rooms, and with maple in all private rooms and laboratories—the cement being left in the breeding and preparation rooms. Maple flooring is more durable than linoleum, does not splinter, and with age grows continuously harder.

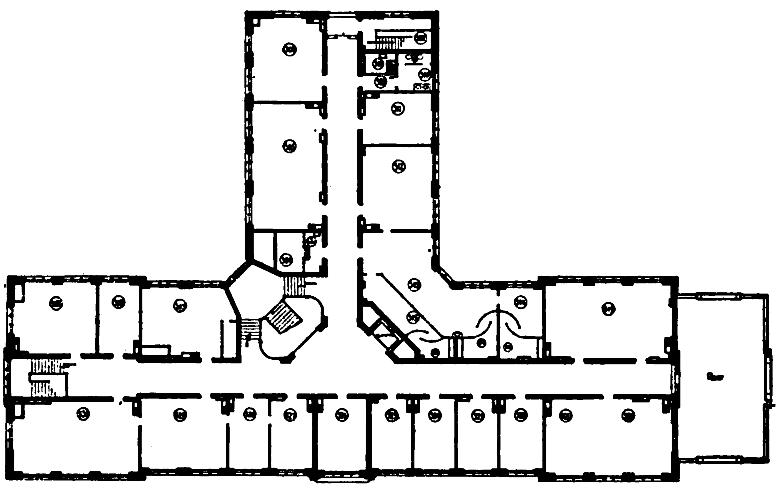
The unit system of construction of rooms has been fairly rigidly followed. Rooms are only 20 feet deep. The largest laboratories, each intended for 24 students, the largest number a demonstrator can direct, measure 20×36 feet, and have three windows; a few smaller laboratories, each intended for 16 students, measure each 20×24 feet and have two windows; the private rooms for investigators range from 20×11 feet to 20×14 feet and have each one window. Each private room is then one third the size of a large laboratory unit. It was considered wisest to keep all private rooms of these dimensions rather than to build larger ones, so as to fully accommodate a considerable number of investigators. The only exception is a large private room (No. 301) for physiology, 20×24 feet. These private rooms for the staff and investigators are situated mostly on the north; there are two of them (Nos. 113, 116) on the first floor, six (Nos. 207, 218, 220, 221, 223, 225) on the second and seven (Nos. 301, 322–328) on the third floor, a total of fifteen. Each of these rooms has a window table two feet wide extending the whole width of the room, supported rigidly on iron brackets fitting into the wall; and a sink in one corner next the hallway. In addition there is a larger room (No. 320) on the third floor to accommodate several workers at once, with a continuous window table on two sides. In each full-sized laboratory there are three working tables, each 4×13 feet, accommodating eight students and placed at right angles to the windows—an arrangement that prevents the demonstrator from interfering with the light of any student; in each table are drawers, and lockers each large enough for a compound and a dissecting microscope and dissecting trays. The inner side of each locker door has two shelves for bottles, and each microscope and its parts bear the same number as the locker. Each student receives a table area of two feet by three and a quarter, one locker and two drawers. In certain laboratories, as those for histology and cytology, these tables contain



Second Floor Plan

gas and electric outlets, and those for physiology and protozoology contain also sinks. The only exception from this general type of large laboratory table are certain special ones for anatomy which are made considerably higher and in smaller units suitable for individual students. Every laboratory has a slate blackboard, 3×12 feet, directly facing the windows, and a sink in each corner of the hallway.

There are two lecture rooms. The large auditorium (No. 10) is reached by the students from the first floor, by the speaker from the basement, and has almost the height of the basement and first floor; it is placed at the junction of the main with the south wing,



Third Floor Plan

utilizing a space not well adapted for other purposes. This has 327 seats without writing arms, with only a moderate rise in their tiers, and four aisles; beneath the large skylight is a system of vertical shutters that may be turned horizontal, so as to exclude the light, by the revolution of a wheel placed beneath the blackboard. The smooth plaster wall above the blackboard furnishes a lantern screen, 11×11 feet. A small lecture room (No. 212) is placed on the second floor, to accommodate sixty students, with separate chairs fitted with writing arms. But lectures may be given in any laboratory room, for all have blackboards.

Nearly opposite the smaller lecture room is a room for charts (No. 206); this contains a metal rack on which Leuckart and Deyrolle charts are hung vertically by hooks.

The library (No. 111) is at the west end of the first floor, and measures 24×44 feet. It is fitted with five double-range metal stacks, and a folio stack; one end of it is a reading space. Adjoining it is a librarian's room (No. 110). The library is to be entered from the librarian's room, so as to prevent ingress of dust from the hallway.

No large museum rooms were planned, only a synoptical museum and rooms for the storage of anatomical collections. It was not thought wise to duplicate in any way the exhibition collections of the museums of Philadelphia, but to make the building strictly a working laboratory.

For the elementary courses in general zoology, four laboratories are provided on the first floor, accommodating ninety-six students at one time. The laboratories for general zoology (Nos. 104, 114, 115, 117) and the auditorium (No. 111) and synoptical museum (No. 101) which are auxiliary to this course, are all placed on the first floor so as to segregate the majority of the students there, and to avoid noise on the stairways. Only as the students proceed to more advanced courses will they pass to the other floors, and thereby ascend the heights of learning. It was not thought necessary to provide any special preparation rooms for the course in general zoology, because each laboratory has its own sinks and preparation tables, besides a demonstration table on castors that may be readily moved from one room into another; there are no sills beneath the doors.

On the first floor, also, is a laboratory for entomology (No. 112), and opposite it one (109) for advanced work on this subject.

For vertebrate anatomy there are two laboratories (Nos. 215, 216) for elementary courses on the second floor, each with two large sinks; these are separated by a sliding accordion partition, so that they may be thrown into one when necessary. Adjoining these is a small room (No. 214) for charts and models and a preparator's room (No. 213); the latter has a chemical hood and a very large sink. Contiguous is also a storage museum (No. 217) with a large wall case for larger mounted skeletons, and a series of vertical cases provided with interchangeable trays and drawers and with lift-off wooden doors fitting almost dust-proof; the latter cases are for alcoholic and other specimens. Another part of the anatomical equipment are two storage rooms (Nos. 12, 13) in the basement for rough collections, and a special preparation room (No. 11) communicating with these; the latter has a specially designed hood for maceration and boiling of skeletons, a large slate table with running water, a heating and drying table, a sink large enough to contain the body of a horse, and an overhead trolley track for the carriage of large objects.

For elementary work in histology and embryology there are two laboratories (Nos. 205, 224) on the second floor. For more advanced courses, especially in cytology and embryology there are two smaller laboratories (Nos. 222, 219) on the same floor, one of these being fitted with an aquarium table.

For protozoology there is one laboratory (No. 226) for elementary work, and opposite it a culture room (No. 201) with southeast exposure provided with an aquarium table.

All these courses demanding much microscopical work are close together and convenient to the special room (No. 202) for paraffine baths and sterilizers, and to the reagent room (No. 203), which has a chemical hood

and is for the housing of all general glassware and reagents.

On the third floor at the east end is the section for physiology. This comprises a large private room (No. 301) with a hood, rigid table for a motor and chemical table; a laboratory (No. 330) for elementary work, with a hood; a glassware and apparatus room (No. 302); a room (No. 329) for motors; and a biochemical laboratory (No. 303) completely outfitted with a large hood and two chemical tables, and enclosing a balance room partitioned off by glass. For the most precise weighing there is a small room (No. 3) in the basement with a built-in pier. A laboratory (No. 319) for animal behavior is placed on the third floor. For the use of both these subjects there are two rooms painted dull black for experiments on reactions to light; one (No. 313) of these is on the third floor, intended especially for the study of the effects of sunlight, and the second (No. 6) considerably larger, is in the basement and provided with built-in piers for the placing of delicate physical apparatus, and with an anteroom (No. 5) for light generators.

Of other general equipment the following may be briefly described:

For photography there is a dark room (No. 9) in the basement for the special use of students. The main space for this purpose, however, is a large room (No. 313) on the third floor, with a skylight over a portion of it, communicating with which are three dark rooms (Nos. 315, 316, 317), one of them especially large for work with the ultra-violet apparatus; and adjoining is a room (No. 314) for microphotography, also with a dark room (No. 318).

In the basement is a machine shop (No. 21) well equipped with metal- and wood-working machinery (lathes and drill presses) for the repair and making of apparatus.

For breeding and other experimental work there are considerable facilities. Within the new building are no aquaria provided beyond special aquarium tables in two rooms. The old vivarium is now devoted almost entirely to aquaria, is well equipped with tanks and pools for fresh water, and with a smaller section for salt water; two new shallow floor pools have been added to it. The wing connecting the vivarium with the new laboratory consists of a keeper's room (No. 120) and of two breeding rooms (Nos. 118, 119) for mammals, the latter with outside wire-enclosed runs; there is another wire enclosure south of the vivarium; the hallway leading to the mammal rooms is closed off from the main south corridor by a special door so as to exclude odors. This mammal wing is raised well above the ground level so as to insure dryness, and is well ventilated.

The large room (No. 105) at the southeast corner of the south wing, immediately adjoin- the mammal wing, is also designed for breeding purposes, particularly for insects, and so is room No. 109 on the same floor. In the basement is a room (No. 20) on the north side for the incubation of hens' eggs. On the third floor are three large rooms (Nos. 305, 306, 311) in the south wing for the future extension of breeding facilities. All these various breeding rooms have drained cement floors. On the east side is a ground area enclosed on three sides by the walls of the building, and it is planned to screen this off for outdoor breeding.

There are four constant temperature rooms. Room No. 15 of the basement is for the cold storage of anatomical material, to be kept at a temperature ranging from 28° to 32° F. Separated from it by a partition is room No. 15A, which measures 5×12 feet, and is for cold constant temperature of from 14° to 32° F. Room No. 16 is for the cooling machinery and room No. 14 for the large brine tank. On the second floor is room No. 204 for constant body temperature, to be heated by the radiation from a gas stove. Room No. 304, on the third floor, is designed to be set constant at any temperature between 32° and 98° F.; it allows the admission of sunlight through the roof, the light passing through a basin of running water. All rooms and anterooms are thoroughly insulated with nonpareil corkboard and provided with Stevenson refrigerator doors. It is designed in each room to keep

the temperature constant within $\frac{1}{2}°$ F. of the point selected. The refrigeration is kept independent of the ventilation; the air for ventilation is cooled in the anterooms to the temperature of the rooms to which it is to be admitted. This matter of ventilation is one of the most difficult, but absolutely necessary when it is intended to keep living animals for long periods. The refrigeration is by the circulation of brine in coils, automatically controlled by thermostats. For the cooling of the brine there are two ammonia-compressors of the vertical single-acting type; one is large enough to operate the entire plant under all conditions; the second with a capacity of half of that of the first. Within constant-temperature rooms where living animals are to be kept there are no ammonia pipes, so that there can be no leakage of ammonia in the rooms.

The direct steam heating is from a central power station, as is also the electric power. All lighting is by electricity. In the basement is the plant (Nos. 17, 18, 19) for ventilation by filtered air, and this is subdivided into systems so that different parts of the building may be ventilated independently of each other. All ventilation conduits are placed within the walls lining the corridors. Steam, gas and water pipes are all exposed, and so are the rain conductors which are inside the building. The sinks, which are in nearly every room of the building, are of soapstone with an ash drain board at one end; most of the sinks measure one and a half by two feet, but certain special sinks for anatomy are much larger; one of the latter is 3 feet deep and 8 feet long. Each bibb has an extra small cock for the attachment of rubber tubing. Bunsen burners are attached to gas outlets by flexible wire tubing.

All tables have birch tops, ebonized. All wall cases are of oak with glass doors, and all the furniture is master-keyed. Drawers and trays of all standard wall cases are interchangeable. The general type of wall case is four feet wide; the upper part is provided with glass doors and shelves, the lower, deeper part with wooden doors and shallow drawers. The usual type of preparation table has a top measuring $1\frac{3}{4} \times 5$ feet, and is of a convenient size to move. Beneath the built-in window tables there are no drawers, so that one may work at any part of them. All chemical hoods have wooden frames in order that the glass may be readily replaced when broken.

The office room (No. 102) is on the first floor between these two entrances that are most used; it is occupied by the stenographer, who also acts as telephone central and keeps student records. There is an intercommunicating telephone system with twelve stations, at any of which a person may call up any station independently of the telephone central. A room (No. 103) for the janitor is placed near the main entrance. For freight there is a room (No. 8) in the basement and also a large space (No. 10A) beneath the seats of the auditorium.

For the use of the men students are two locker rooms in the basement, with vertical lockers of expanded metal, adjoining which is a large lavatory (No. 2) and a smoking room (No. 4). There is a separate toilet for janitors (No. 7). For women is provided a locker and sitting room (No. 108) on the first floor, with lavatory (No. 107) contiguous. On the second and third floors are other toilet rooms (Nos. 211, 310), that of the second floor provided with a bath for the convenience of any investigator who chooses to reside in the building.

The whole building has been made as elastic as possible so as to provide for future needs. Partitions between rooms are of terra cotta and may be easily removed; it will prove cheaper to tear down partitions so as to make larger rooms when necessary than to have large rooms at the start and later erect partitions in them.

Thomas H. Montgomery, Jr.
University of Pennsylvania

THE CHEMIST AS A CONSERVATIONIST

It is remarkable, if one has not given the matter serious consideration, to what extent the chemist is interested and concerned in the conservation movement, that has recently been agitated in this country. This was especially

emphasized by the papers that were read and the discussions presented at the recent meeting of the third National Conservational Congress in Kansas City. It was intended that this should be especially a "Soil Conservation" meeting, and as such great prominence was given to this topic.

Ever since the settlement of this country, its abundant soil resources have been drawn upon, or there has been, as A. P. Grout puts it, a literal "Rape of the Soil." The fertility was earliest exhausted on the thin soils of the eastern states, but it is only a matter of time when the abundant cropping will tell all over the country; and in fact the important mineral constituents of the soil will be practically exhausted. We are not a people who can sit down and wait for nature, through the slow decomposition processes and through vegetation, to again render the soil fertile. The chemist must come forward and show how cheap phosphorus, cheap potash and cheap nitrogen can be obtained. The physical character of the soil must be studied in order to secure better cultivation and greater adaptability of crops to environment.

The water supplies of the country should be more thoroughly understood. Not only must the engineer utilize the pent-up mountain torrents for producing power or for irrigation, but the surface and ground waters must also be used as domestic and municipal supplies. The quality of this water should be known, and the conditions favorable to maintaining its purity are to be investigated in the laboratory. Again, with the growing manufacturing industries, the industrial waste has to be taken care of in some way so that the health of the people be conserved, and the streams remain unpolluted. If the sewage is allowed to enter the streams, it must be so purified that it is no longer sewage. Water-softening plants are now deemed a necessity whenever the water is not soft enough for laundry and domestic use.

We realize that our wood supply is rapidly wasting away, and there is need of care to prevent waste not only in the cutting of timber for lumber purposes, and in the precautions against forest fires, but also in the utilization of the immense quantities of waste in smaller limbs, roots and slabs. This, J. B. White asserts, is often as much as 60 per cent. of the tree. Here is an almost inexhaustible supply of material which, as has been shown by G. B. Frankforter and other chemists, may be utilized in the manufacture of charcoal, acetic acid, wood alcohol, tar, resin oil, acetone, gas and turpentine. The sawdust chokes the streams and kills the fish; use it as a fuel or for the manufacture of chemicals.

In this same connection it is worth while to notice that the need for so much wood in construction has gradually been decreased by using Portland cement. The chemist has tested the limestones and shale, and can tell where cement can be made at a profit. He studies the market, the supply of raw material and the cost of transportation of fuel for a given locality.

A few years ago our people went on the principle that the supply of natural gas as fuel was practically inexhaustible, but now that they have begun to realize their error from the shortage in many states, they are trying to make the gas last as long as possible. Other fuels are investigated by the chemist and we are familiar with the use of "process-gas" and petroleum burners. The "slack" from the mines is molded into "briquettes," and used as domestic fuel.

That the "live-stock farm" will do much towards preserving the fertility of the soil is the belief of F. B. Mumford. It seems very reasonable that if the farmer returns to the soil the barnyard manure from his stock, the more important chemical ingredients will be retained. If, on the other hand, he sells his crops, such as corn, wheat and hay, the land will soon show signs of depletion.

In the utilization of by-products no one is more active than the chemist. He shows how all the waste material may be utilized at the packing house, how the whey from cheese manufacture may be used to make milk sugar; how the casein may be made into buttons or dried and used in the arts; how the cotton seed may be utilized for making oil, and for a stock food; how peanut oil may be used to take the

place of lard; how the once despised coal tar may be made the basis for the manufacture of dyes and scores of organic chemicals, and how the waste lye of the soap-boiler may be used for the manufacture of glycerine.

In the preservation of the life and health of the children, who is more concerned and active than the expert who studies the composition of the air they breathe in the school room, and of the water they drink, at home? What more efficient help can be afforded to the people at large than that given by the various pure-food laboratories, both state and national? The foremost object of these laboratories is to safeguard the public against impure and injurious foods, and to protect them from the frauds of mislabeling and misbranding.

In the department of domestic science in the schools and colleges, much of the instruction is in these same lines, *i. e.*, to teach what is good food, wholesome surroundings, pure air, a sanitary dwelling; in all of this and similar work the chemist is continually giving his help, and by his investigations advancing the well-being of the community, so as to make life more worth the living.

E. H. S. Bailey

CYRUS G. PRINGLE

Cyrus G. Pringle was born in Charlotte, Vermont, May 6, 1838, and died in Burlington, Vermont, May 25, 1911. At an early stage his studies at the University of Vermont were interrupted by the death of his father and he was compelled to return to the home farm to assist his mother in the support of the family.

Always interested in botany and horticulture, he declared in 1869, "My chief study shall be the adaptation of our beautiful Valley of Lake Champlain to horticultural pursuits"—the development of his native valley was the ambition of his life.

He began with a comparative study of the climatic conditions of the Champlain valley and of the adjoining horticultural areas. He followed this study by introducing plants from more southern areas and testing them under Vermont conditions. Finally, he attempted to improve plants which could be grown under these conditions, by breeding and selection. It was in this field that he attained his greatest success.

Dr. Pringle laid a broad foundation for his work. He visited nearly all persons in this country who were engaged in the improvement of plants by breeding and selection, studying their methods and results. February 24, 1869, he imported a copy of Lecog's work on hybridization. While waiting at the mill for his turn to have his wheat ground, he learned to read French and pursued the study of Lecog's work.

As might be expected from such a man, he soon gained a wonderful insight into the nature of plants and success crowned his efforts. In a short time his farm became well known both to scientists interested in the laws of plant breeding and to horticulturists and seedmen seeking new varieties. Among his early friends and visitors was Luther Burbank.

Dr. Pringle did not limit his work to any one line of plants, but included all kinds, both useful and ornamental, which might help to develop his native state. Some idea of the scale on which he worked may be gained by a study of his early records. These show that he set out 1,500 apple and 600 pear stocks for an experiment in adaptation; that he was carrying on breeding experiments with over 25 species of plants, including cereals, potatoes, grapes, pears, plums, apples, cherries, a variety of ornamental plants and others; and that in every case he was working with very large numbers of individuals. His collection of bulbs of ornamental plants was the largest in point of variety, not only in the United States, but in the world.

He was able to originate and place on the market three potatoes of special merit. These were the Snowflake, the Alpha and the Ruby. The first attained great popularity and was sold at a large figure to a New York house. This house paid him as high as $1,000 per pound for potato seed. In cereals he originated the Defiance Wheat, the Champlain Wheat and Hulless Oat. The first of these "has been for years the standard wheat for

irrigated sections in Colorado and adjoining states."

Only about ten years was devoted to the work outlined above. In that brief period he accomplished much. His farm was an experiment station teeming with possibilities when adverse circumstances caused him to give up this work. In a short time he turned his attention entirely to collecting and he became a botanical explorer. He began his collections in Vermont, but gradually extended his field to include the lower St. Lawrence, the Pacific slope, the southwestern states and territories, and finally Mexico.

Early in his career as a botanical collector of rare ferns in the Green mountains, he became acquainted with Professor Asa Gray, who later styled him "the prince of botanical collectors." Dr. Gray was engaged at that time upon his "Synoptical Flora of North America" and he assigned to Dr. Pringle the investigation of the flora of Mexico, "charging him, as they sat with a map spread before them, to ascertain especially the southern limit of distribution of species found in the United States and also to ascertain what related species might be indigenous in the adjacent regions of Mexico."

His first trip to Mexico was begun February 25, 1885. He was cordially received by the Mexican government officials, who gave him every possible assistance in his work, including letters to subordinates, special police protection when necessary, railroad passes for himself and assistants, etc. During the following twenty-six years he made thirty-nine trips to Mexico, sometimes bringing home large collections, sometimes returning emptyhanded on account of sickness either of himself or his assistant. During this period he was able to travel over large areas and collect from many localities. He collected the desert flora of the arid interior plains of the great northern states; the alpine plants from the mountains capped with perpetual snow; the rich flora of the tropical jungles along the coast and lowlands.

As official collector for Harvard and the National Museum, he made for each institution a set of all his collections in addition to the set which he made for his own herbarium. However, he did not confine himself to these three sets, but attempted in every case to collect 60 extra sets for purposes of sale and exchange. These sets are to be found in all the large herbaria of the world. I believe it is now impossible to furnish complete sets. He brought out of Mexico alone over 12,000 numbers, very many of which were new to science.

His own herbarium, now the property of the University of Vermont, "The Pringle Herbarium," contains about 160,000 mounted plants and occupies two rooms, each 40 by 45 feet, in addition to office and storeroom. He was very busy the past winter making exchanges and buying plants to increase its size. The additions he made this year will approximate 30,000.

During the past year Dr. Pringle, although far from being as vigorous in bodily health as he was mentally, hoped to make another trip. Owing to the revolution in Mexico, he was considering South America as a field for this work, but his indomitable will and energy had carried him beyond his strength and an attack of pneumonia together with other complications cut short the life that had been so full of energy and masterful achievements.[1]

GEORGE P. BURNS
UNIVERSITY OF VERMONT

THE INAUGURATION OF THOMAS EDWARD HODGES AS PRESIDENT OF WEST VIRGINIA UNIVERSITY

THE formal inauguration of Dr. Thomas E. Hodges, late member of the State Board of Control, and formerly professor in the university, as president of the State University of West Virginia took place on Friday, November 3, 1911.

The various exercises incident to the inauguration lasted several days, and were initiated by President Taft, on Wednesday morning, when he addressed a large gathering of

[1] An extended biography of Dr. Pringle by Professor Ezra Brainard will soon appear in *Rhodora*.

university and town people from the steps of one of the university buildings.

This meeting, which was presided over by Governor William E. Glasscock, being of an academic rather than of a political character, the President refrained from the discussion of politics, and, after a few remarks of a congratulatory character, spoke at some length upon the subject of the "Judicial Settlement of International Disputes."

The next exercise of a formal character was the "Educational Meeting" of Thursday night, at which the State Superintendent of Education, Morris P. Shawkey, presided. The program consisted of two formal addresses and several musical selections.

The first address was by Dr. Fletcher B. Dressler, of the United States Bureau of Education, upon the "Duties and Opportunities of the Modern Scholar."

The second address was by President Edwin A. Alderman, of the University of Virginia, upon "The Universities and the National Spirit."

The exercises of Friday morning, presided over by Retiring-President Daniel B. Purinton, began with an academic procession of the visiting delegates and the local faculties to the assembly hall.

After a musical number and the invocation the delegates, more than sixty in number, and representing institutions of learning and scientific bodies from Maine to California, were formally introduced by Dr. Robert A. Armstrong, chaplain of the university. The chief part of the program consisted of short greetings from eight or ten of the delegates.

The actual inaugural exercises, followed by a general reception at the Armory, took place on Friday afternoon, Governor Glasscock again presiding. After the entrance of the academic procession, a musical selection and the invocation, the charge to President Hodges was delivered by Hon. Morris P. Shawkey, president of the State Board of Regents, which was followed by the acceptance by President Hodges.

The first address of the day was by President Harry Pratt Judson, of the University of Chicago, on "The University and the State." This was followed by an address by President William Oxley Thompson, of the Ohio State University, on "The University and the People." The dominant note of these two addresses seemed to be "practical service" by the state university to the taxpayers who support the university.

Following these two addresses was President Hodges's inaugural address. This was, to some extent, a brief review of the history of the institution and a statement of some of the fundamental policies which he expects to follow in the future. While he did not in the least belittle the importance of the "practical service" aspect of university work, he emphasized more than did some of the other speakers the importance of and his desire to encourage the pure sciences and the purely cultural subjects. He expressed the belief that it would be better policy for the university to endeavor to build up existing departments rather than to create new ones, though he expressed the hope that it would not be long before it would be possible to lay more emphasis upon graduate work.

On Friday evening was held a Pan Hellenic Reunion, preceded by a torchlight procession of students and alumni. This was, of course, of an entirely informal character, and was in charge mainly of the younger alumni of the university.

Saturday was called "West Virginia Day," and the exercises consisted mainly of addresses by alumni of the university who have become prominent in some phase or other of the state's activities.

The weather was almost ideal, and the entire program was carried out without a single hitch.

With a president of force and energy, who has the confidence alike of his faculties and fellow statesmen, it would seem that a new and greater era is about to begin for West Virginia University.

A. M. R.

THE SOUTH KENSINGTON SOLAR PHYSICS OBSERVATORY

THE report of the Departmental Committee on the Solar Physics Observatory, now at South Kensington, has been issued as a Parliamentary paper and an abstract is given in the London *Times*. The committee was composed of Sir T. L. Heath, assistant secretary of the treasury (chairman); Mr. F. W. Dyson, F.R.S., astronomer-royal; Dr. R. T. Glazebrook, F.R.S., director of the National Physical Laboratory, and Professor Arthur Schuster, F.R.S., chairman of the executive committee of the International Union for Solar Research, with Mr. F. G. Ogilvie, C.B., as secretary.

The terms of reference were:

To consider the alternative schemes for locating the Solar Physics Observatory at Fosterdown and at Cambridge, respectively, and to report which of the two schemes is likely to secure the best results for an annual expenditure of approximately the same amount as is now incurred for the work done under the direction of the Solar Physics Committee.

The committee discuss the question in considerable detail, and three of them—Sir T. L. Heath, Mr. Dyson and Professor Schuster—agree on the following "conclusion and recommendations":

We are of opinion that, on a balance of considerations, and especially having regard to the advantage to the progress of solar physics which may be expected to accrue from the establishment and support by the university of a real school combining the studies of solar physics and astrophysics, the Cambridge scheme is calculated to give the better results for an expenditure of approximately the amount now available for the Solar Physics Observatory.

We recommend, therefore, that the solar physics work be transferred to Cambridge, with an initial grant for buildings and a fixed annual inclusive grant-in-aid to the university, provided that the university will agree to the following conditions:

1. That the professor of astrophysics be the director of the Solar Observatory.

2. That there be a committee or syndicate nominated by the university with functions similar to those of the board of visitors of the Royal Observatory at Greenwich.

3. That the astronomer-royal and the director of the Meteorological Office be *ex officio* members of the committee or syndicate.

4. That the university undertake to carry out at the new observatory the necessary amount of routine work on the general lines indicated in paragraph 14 (*b*) and (*c*).

5. That an annual report, to include a statement of the work done, and an abstract of the accounts of the Solar Observatory showing the application of the grant-in-aid, be presented by the director to the committee or syndicate, to be by them transmitted to the Treasury.

With a view to securing the permanence of any arrangement that may now be made, the committee desire to point out the importance of attaching the directorship of the Solar Observatory, if established at Cambridge, to a professorship which is not merely of a temporary character. The university may not be in a position at present to give any definite assurance that the professorship will be renewed at the expiration of the present tenure; but we consider it highly desirable that the government should ascertain, before coming to a final decision, whether the university is willing at an early opportunity to consider favorably the establishment of a professorship of astrophysics on a permanent foundation.

Dr. Glazebrook, however, dissents with great regret from his colleagues' conclusion and recommendations. He says:

I believe that the evidence placed before the committee and the facts detailed in the report lead to the conclusion that, on a balance of all the considerations, a scheme for locating the observatory at Fosterdown . . . could be arranged at an annual cost of £3,000, with a capital outlay of £5,000, and would secure the best results.

It appears from an appendix that Sir Norman Lockyer, F.R.S., director of the Solar Physics Observatory, is not in favor of the transference to Cambridge, and recommends the Fosterdown site.

SCIENTIFIC NOTES AND NEWS

THE Jean Reynaud prize of ten thousand francs, awarded by the Paris Academy of Sciences every five years, has been bestowed this year on Professor Emile Picard, for his contributions to mathematics.

The De Morgan medal of the London Mathematical Society has been awarded to Professor Horace Lamb, F.R.S., for his researches in mathematical physics.

The Royal Scottish Geographical Society has awarded its gold medal to Mr. J. Y. Buchanan, F.R.S., for his services to geography, especially in oceanographical research.

Mr. Frederick Gowland Hopkins, M.A., F.R.S., formerly fellow and tutor, and Mr. Rowland Harry Biffen, M.A., professor of agricultural botany, have been elected honorary fellows at Emmanuel College, Cambridge.

Professor Peter Schwamb, who graduated from the Massachusetts Institute of Technology in 1878 and was appointed instructor there in 1883, being since 1901 professor of machine design, has retired from active work under the provisions of the Carnegie Foundation.

Mr. R. J. Godlee has been elected president of the Royal College of Surgeons of England, in succession to Sir Henry Butlin.

In reply to an inquiry as to the award of the Nobel prizes, Professor Svante Arrhenius has sent to *Nature* the following information: (1) *Prize for medicine:* awarded on October 21, the birthday of Dr. Alfr. Nobel, by the Carolinian Institute (faculty of medicine) in Stockholm to Dr. Allvar Gullstrand (born 1862), professor of ophthalmology in the University of Upsala, Sweden, for his investigations in physiological optics. (2) *Prize for physics:* awarded on November 7 by the Royal Academy of Sciences, Stockholm, to Dr. Willy Wien (born 1864), professor of physics at the University of Würzburg, Bavaria, for his discoveries regarding the laws of radiation. (3) *Prize for chemistry:* awarded on November 7 by the Royal Academy of Sciences, Stockholm, to Mme. Marie Curie (born 1867), professor of physics in the University of Paris (Sorbonne), for her discoveries of the chemical elements radium and polonium, and her investigations regarding their chemical properties. Mme. Curie received, together with her husband, the half of the Nobel prize for physics in 1903 for their investigations regarding the Becquerel rays. (4) *Prize for literature:* awarded on November 9 by the Royal Swedish Academy of Literature, Stockholm, to Maurice Maeterlinck (born 1862). The prize for work in the cause of peace will probably not be awarded before December 10, the day of Dr. A. Nobel's death, by the Storthing (Parliament) in Christiania, Norway.

Professor W. E. Castle, of the Bussey Institution, Harvard University, has gone on a zoological expedition to Peru, to be absent about three months. His headquarters will be at the Harvard Astronomical Observatory, Arequipa.

Dr. D. T. MacDougal and Mr. G. Sykes, of the Desert Botanical Laboratory, will visit the region between Khartoum and the Red Sea early in 1912, and later undertake some extended work in the Libyan oases. Attention will be devoted chiefly to the extension of studies on the features of desert basins upon which some work has been done in the Salton, and in the Otero basin in New Mexico. Dr. MacDougal sailed to join Mr. Sykes in England on November 23. He will lecture on "North American Deserts" before the Royal Geographical Society on December 18.

Lieut. Col. Edgar A. Mearns, U.S.A., retired, associate zoologist of the United States National Museum, who accompanied the Smithsonian expedition to Africa, under the direction of Colonel Theodore Roosevelt, will be attached as naturalist to the Childs Frick Abyssinian expedition, which shortly sails from London to make natural history collections in the Abyssinian region. The party will consist of Mr. Childs Frick, son of Mr. Henry C. Frick, Mr. Blick, a friend of the former, Dr. Mearns and a physician. It is the plan of the organizer to make as complete a collection of the animals of the Abyssinian region as possible. The birds will be prepared by Dr. Mearns for the National Museum, where they will be studied and reported on; the other animals, including big game, will be prepared by Messrs. Frick and Blick, both of whom have taken preliminary lessons in taxidermy and field prepa-

ration in order to qualify themselves as field taxidermists. Dr. Mearns recently sailed from New York on the *Mauritania* for London. From there the party will go to Aden, Arabia, on the Gulf of Aden, where they will outfit. They will then cross the Gulf of Aden and plunge directly into the wilderness.

THE Entomological Society of America offers each year at its annual meeting held during convocation week an evening lecture dealing with some phase of insect morphology or ecology of particular interest to zoologists and entomologists. This lecture will be given this year by Professor John Henry Comstock, of Cornell University, on Wednesday evening, December 27. His subject will be, "On Some Biological Features of Spiders." The lecture will be illustrated with lantern slides.

ON November 16 the New York Academy of Medicine held its anniversary meeting. The address of the evening was made by Dr. James Ewing, New York City, who took for his subject "The Medical Profession and the Public."

DR. G. STANLEY HALL, president of Clark University, delivered the address at the inauguration of Dr. George E. Myers, principal of the State Manual Training Normal School at Pittsburg, Kansas. The subject of the address was "Educational Efficiency."

PROFESSOR JOSEPH JASTROW, of the University of Wisconsin, will give a public lecture "On the Trail of the Subconscious," at the university on December 4, under the auspices of the university association for research and Phi Beta Kappa.

ON the evening of November 18 Professor W. Johannsen, of the University of Copenhagen, lectured before the Indiana Chapter of Sigma Xi and invited guests on the subject "Selection in the Light of Pure Line Work." The lecture was followed by a formal reception. The officers of the Indiana Chapter of Sigma Xi for the current year are: *President,* Dr. J. W. Beede; *vice-president,* Dr. C. E. May; *recording secretary,* Dr. Ferd. Payne; *corresponding secretary,* Miss Mary Harmon; *treasurer,* Dr. F. C. Mathers.

PROFESSOR S. A. MITCHELL, of Columbia University, has been lecturing in Philadelphia on successive Saturdays, beginning November 4 on the subject of "Astronomy." The titles of the lectures are (1) "Common Things about the Earth," (2) "The Sun—Typical Star," (3) "Evolution Revealed by the Spectroscope," (4) "The Moon, a Worn-out World," (5) "Fragments of other Worlds," (6) "Is Mars Inhabited?"

THE first lecture in the season's course of the Montreal Branch of the Archeological Institute of America was delivered in the chemistry building at McGill University, Montreal, by Harlan I. Smith, dominion archeologist, on the subject "The Archeology of Western Canada."

THE eighty-sixth Christmas course of juvenile lectures, founded at the Royal Institution in 1826 by Michael Faraday, will be delivered this year by Dr. P. Chalmers Mitchell, F.R.S., secretary of the Zoological Society, on "The Childhood of Animals."

THE Berthelot memorial lecture of the Chemical Society was delivered by Professor H. B. Dixon, F.R.S., on November 23.

THE annual Huxley memorial lecture of the Royal Anthropological Institute was delivered on November 23 by Professor F. von Luschan, whose address was on "The Early Inhabitants of Western Asia."

PROFESSOR KARL PEARSON is preparing a memoir on the life and work of the late Sir Francis Galton.

SURGEON GENERAL WALTER WYMAN, of the U. S. Public Health and Marine Hospital Service, died on November 21, aged sixty-three years.

MR. DANIEL F. DRAWBAUGH, the American inventor, has died at the age of eighty-four years.

SIR SAMUEL WILKES, an eminent London physician, author of works on pathological anatomy, died on November 8, at the age of eighty-seven years.

DR. R. D. ROBERTS, registrar of the Board of Extension of University Teaching, University of London, at one time university lec-

turer on geology at Cambridge, died on November 14, at the age of sixty years.

Among the New York State Civil service examinations on December 9 is one for bacteriologist of the Port of New York at a salary of $1,200.

The annual meeting of the Society of American Bacteriologists will be held in Washington, D. C., December 27, 28 and 29, 1911. The headquarters will be at the New Ebbitt and the sessions at the Cosmos Club. A six o'clock dinner will be given at the Cosmos Club on December 28. The president's address, by Professor F. P. Gorham, considering "Biochemical Problems in Bacteriology," will follow the dinner. The report of the Committee on Microbiological Teaching and Education will be presented after the president's address by the chairman, S. C. Prescott. The whole field will then be open for discussion. Some of the session programs are already in the hands of the secretary. Any one wishing to present a paper should write one of the individuals named below who has in charge the general topic under which the subject may fall: *Systematic Bacteriology,* Professor C. E. A. Winslow, College of the City of New York, New York; *Physiologic Bacteriology* (including antibodies), Dr. John F. Anderson, director of the Hygienic Laboratory, 25th and E Streets N. W., Washington, D. C.; *Soil Bacteriology,* Professor Jacob G. Lipman, director of the Experiment Stations, New Brunswick, N. J.; *Dairy Bacteriology,* Professor E. G. Hastings, College of Agriculture, University of Wisconsin, Madison, Wis.; *Plant Pathologic Bacteriology,* Professor F. L. Stevens, North Carolina Agricultural College, West Raleigh, N. C.; *Human and Animal Pathologic Bacteriology,* Dr. M. Dorset, chief of the Biochemic Division, Bureau of Animal Industry, Washington, D. C.

As already announced, the eighteenth International Congress of Americanists will be held in London May 27 to June 1, 1912. Members who desire to inspect Dr. W. Allen Sturge's magnificent collection of stone implements in his museum at Icklingham Hall, Suffolk, should communicate with Miss A. Breton, Royal Anthropological Institute, 50 Great Russell Street, London, W. C. A visit can be made in the day from London; Dr. Sturge will arrange for conveyance from the station.

The installation of the work of the Venice Marine Biological Station of the University of Southern California occurred on November 10. Addresses were delivered by President Bovard, Mr. Abbot Kinney, Professor Ulrey, Dean Healy and Professor Edwards. Through the generous cooperation of the Abbot Kinney Company the station has a biological reservation consisting of the Venice pier and breakwater and of one and one half miles of canals. The protected breakwater will be used by Professor Edwards for his work under the California Fish and Game Commission on the colonization of the various species of abalones and other forms and for experiments in pearl production. The canals, with water having 75 per cent. of the salinity of the contributing sea, will be devoted to acclimatization cultures. A motor sloop, the *Anton Dohrn,* has been completed for work in the neighboring region, including the islands off the coast of Southern California.

We learn from *Nature* that the council of the Royal Institute of Public Health has accepted an invitation from the chief burgomaster of Berlin to hold the congress next year in that city on July 25–28. The congress will include the following sections and presidents: state medicine, Sir T. Clifford Allbutt, K.C.B., F.R.S.; bacteriology and comparative pathology, Professor G. Sims Woodhead; child study and school hygiene, Sir James Crichton-Browne, F.R.S.; military, colonial and naval, Major Sir Ronald Ross, K.C.B., F.R.S.; and municipal engineering, architecture and town planning, Mr. P. C. Cowan. Facilities will be afforded for visiting the various public health and educational institutions in Berlin in connection with the Imperial Board of Health, the municipality and the university.

It is reported in *Nature* that in connection with the two hundredth anniversary of the

foundation of the Spalding Gentlemen's Society, in 1709, the society has recently built a home for its library and museum, which also includes a magnificent lecture theater, committee rooms, etc. The new building was opened on October 25 by Sir Henry H. Howorth, K.C.I.E., F.R.S., who referred to the extraordinary fact that a society should have carried on its work for two centuries and should then be in a position to purchase a building for its treasures. In the evening there was a public lecture on "The Romans in Lincolnshire," by Mr. T. Sheppard, in which he described many thousand relics of the Roman period, now in the museum at Hull, from a little-known site on the north Lincolnshire coast. Sir Harry Howorth occupied the chair. During the day Mr. Sheppard also gave an address on the use and value of local museums.

In the general estimates for appropriations for the fiscal year 1912, which begins July 1, 1912, Secretary of the Interior Walter L. Fischer has recommended the following items for the Bureau of Mines: For the investigation as to the causes of mine explosions, methods of mining, especially in relation to the safety of miners, the appliances best adapted to prevent accidents, the possible improvement of conditions under which mining operations are carried on, the use of explosives and electricity, the prevention of accidents, and other inquiries and technologic investigations pertinent to the mining industry, $360,000. For the investigation, analyzing and testing of the coals, lignites and other mineral fuel substances belonging to or for the use of the United States, $135,000. For investigations into the treatment of ores and other mineral substances, with special reference to the prevention of waste in the mining and utilization of important mineral resources, $100,000. For the investigations of the coals of Alaska, with reference to their mining, transportation and utilization, $50,000.

The total coal production of the world in 1910 was approximately 1,300,000,000 short tons, of which the United States contributed about 39 per cent. This country has far outstripped all others, and in 1910, according to the United States Geological Survey, it exceeded Great Britain, which ranks second, by over 200,000,000 tons. Great Britain's production in 1910 was less than 60 per cent. of that of the United States, and Germany's was less than half. The increase in both of these countries in 1910 over 1909 was comparatively small, whereas the increase in the United States was nearly equal to the entire production of France and was more than the total production of any foreign country except Great Britain, Germany, Austria-Hungary and France. The United States has held first place among the coal-producing countries of the world since 1899, when it surpassed Great Britain. In the 11 years since 1899 the annual output of the United States has nearly doubled, from 253,741,192 short tons to 501,596,378 tons, whereas that of Great Britain has increased only 20 per cent., from 246,506,155 short tons to 296,007,699 tons. The following table shows the coal production of the principal countries of the world in 1910, except those for which only the 1909 figures are available:

United States (1910)	501,596,378
Great Britain (1910)	296,007,699
Germany (1910)	245,043,120
Austria-Hungary (1909)	54,573,788
France (1910)	42,516,232
Belgium (1910)	26,374,986
Russia and Finland (1910)	24,967,095
Japan (1909)	16,505,418
Canada (1910)	12,796,512
China (1909)	13,227,600
India (1909)	13,294,528
New South Wales (1909)	7,862,264
Spain (1909)	4,546,713
Transvaal (1910)	4,446,477
Natal (1910)	2,572,012
New Zealand (1909)	2,140,597
Mexico (1909)	1,432,990
Holland (1909)	1,235,515
Queensland and Victoria	1,119,708
Italy (1909)	611,857
Sweden (1909)	272,056
Cape Colony (1909)	103,519
Tasmania (1909)	93,845
Other countries	5,236,903
Total	1,278,577,812

Secretary Wilson has decided that the interests of cities and towns which obtain their water from streams having their watersheds within national forests call for special measures of protection, and he has therefore developed a plan of cooperation for the Department of Agriculture with those communities which are alive to the importance of keeping their water supply pure. There are many western towns and cities, some of them of large size, which derive their water from drainage basins lying inside the national forests. One of the recognized objects of forestry is to insure the permanence and protect the purity of municipal water supplies. As the forests are maintained for the benefit of the public Secretary Wilson considers it the duty of his department to do all that it can both to prevent the pollution of such supplies and to create or maintain conditions most favorable to a constant flow of clear water. Stock raising and occupancy of the land for the various kinds of use which are ordinarily encouraged on the national forests may be highly undesirable if allowed on drainage basins which are the sources of drinking water. There is also to be considered the injury which may be done if the water is silt-laden. By protecting and improving the forest cover and by enforcing special regulations to minimize erosion and to provide for the maintenance of sanitary conditions, the government will try to safeguard the interests of the public. A form of agreement has been drawn up, providing that, when cooperation is entered into between the Secretary of Agriculture and any city desiring conservation and protection of its water supply, the secretary will not permit the use of the land involved without approval by the town or city except for the protection and care of the forests, marking, cutting and disposing of timber which the forest officers find may be removed without injury to the water supply of the city, or for the building of roads, trails, telephone lines, etc., not inconsistent with the objects of the agreement, or for rights of way acquired under acts of Congress. The secretary also agrees to require all persons employed on or occupying any of the land both to comply with the regulations governing national forests and to observe all sanitary regulations which the city may propose and the secretary approve. The agreement provides for the extension and improvement of the forests on the part of the government by seeding and planting and the best methods of silviculture and forest management, so far as the funds available will permit. The city on its side is expected to assist in the work by paying the salaries of the additional guards necessary to carry out the agreement, and in case extensive forest operations are immediately desired by the city, it would bear the major part of the cost entailed by this work.

Anti-typhoid vaccine will be supplied to Wisconsin physicians free of charge by the state hygienic laboratory at the University of Wisconsin, beginning on December 1, according to the announcement just made by Dr. M. P. Ravenel, head of the department of bacteriology at the state university and director of the laboratory. When the vaccine is ready for distribution full directions for its use will be issued, the only condition being that physicians agree to make a report of the results to the laboratory. To prevent the spread of typhoid it is recommended that where one case of typhoid fever occurs in a family, the other members be vaccinated promptly. In the distribution of the vaccine the authorities of the hygenic laboratory desire to secure the cooperation of physicians generally, and with that end in view are requesting that suggestions be made by practising physicians before the distribution begins, December 1. The decision of the director of the hygienic laboratory to furnish anti-typhoid vaccine grows out of the success which has attended its use in the United States army, where the results have been so striking that the secretary of war, acting on the advice of the surgeon general, has made anti-typhoid vaccination compulsory for all officers and enlisted men under

45 years of age. Before it was made compulsory, 17,000 officers and enlisted men had been vaccinated voluntarily. During the recent mobilization of troops in Texas, when the men were in camp for more than two months, under war conditions, only one case of typhoid resulted, that of a teamster who had not been vaccinated. This was in striking contrast to the Spanish-American war when within a period of three and one half months there were 20,738 cases with 1,580 deaths.

UNIVERSITY AND EDUCATIONAL NEWS

LARGELY through the efforts of Mrs. E. H. Harriman, a fund of $40,000 a year for five years has been provided to maintain an experimental school for the study and administration of public business. The school will be started in New York, but the scope is intended to be national. Mrs. Harriman personally consulted a number of business men, journalists, educators and public officials as to the need of providing such a training school, and their favorable replies resulted in her offer of a contribution to make possible a five years' test of such a school. Her own contribution was $40,000 for the first year and $10,000 for the succeeding years. Messrs. John D. Rockefeller, Andrew Carnegie, J. P. Morgan and others gave enough to provide for a total annual income of $40,000. The work will be carried on by the directors of the Bureau of Municipal Research.

THE statute allowing honor students in mathematics and natural science to dispense with Greek in responsions passed the Oxford congregation on November 7 by a vote of 33 to 11. It will now be submitted to convocation, the ultimate legislative authority of the university.

DR. EDMUND B. HUEY, who has for some time been making examinations of defective children and of aphasic patients at the Johns Hopkins Hospital, has been appointed lecturer on mental development in the Johns Hopkins University and assistant in psychiatry in the Phipps Clinic of the Johns Hopkins Hospital. From January to June, 1912, Dr. Huey will give, at the university, a series of weekly public lectures and clinics on the subject of backward and feeble-minded children, and on related phases of clinical psychology.

DR. ALFRED N. GOLDSMITH has been appointed instructor in physics in the College of the City of New York.

DR. ALEXANDER F. CHAMBERLAIN, hitherto assistant professor, has been promoted to a full professorship in anthropology at Clark University.

PROFESSOR R. I. SMITH, of the North Carolina College of Agriculture, has accepted a position with the Porto Rico College of Agriculture, taking up extension work in agricultural education. His address after January 1, 1912, will be Mayaguez, Porto Rico.

DISCUSSION AND CORRESPONDENCE

THE USE OF SODIUM BENZOATE AS A PRESERVATIVE OF FOOD

TO THE EDITOR OF SCIENCE: It seems proper that the following quotation of the Prussian Scientific Deputation of Medical Affairs should be published in addition to that copied by SCIENCE from an article in the *Journal of the American Medical Association*, that the American public shall not be misled:

> In order to decide the question concerning the use of benzoic acid and its salts as a preservative of food, one must consider the result of the prolonged administration of these substances in small doses. Such experiments were carried out on twelve young men in the chemical laboratory of the Agricultural Department in Washington under the direction of Wiley. The persons experimented on received, in increasing quantities, between 0.5 to 2.5 grams of benzoic acid or benzoate in capsules during four periods of five days each. The majority of the persons experimented on experienced digestive and metabolic disturbances, gastric pain, vomiting and reduction in body weight, which decided Wiley to declare that the use of benzoate salts should not be allowed in the preservation of food. Since, however, doubts arose regarding the technic of these experiments and since the injury to the health of the individuals could not with certainty be attributed to the use of benzoate of soda, an American commission ap-

pointed by President Roosevelt has tested Wiley's results. Three independent series of experiments were carried out extending over a period of four months, by R. H. Chittenden at the Sheffield Scientific School, Yale University, on six young men, by J. H. Long at the Medical School of the Northwestern University in Chicago on six individuals and by Christian A. Herter in his private laboratory of Columbia University on four individuals. The experiments were so arranged that during two months 0.3 gram of sodium benzoate was given daily in three doses in the food or drink. During a third month the dose given was gradually increased at first to 0.6 and then to 1 gram, while in some experiments 4 and 6 grams were given daily. The experiments in which the dose of 0.6 to 1 gram were given lasted between 8 to 14 days, and with the largest doses 2 to 8 days. The food ingested and the excreta were analyzed and the individuals were carefully observed. The commission draws the following conclusions:

1. Sodium benzoate in small doses (under 0.5 gram) when given with food is harmless, is not poisonous and not injurious to health.

2. Larger doses of sodium benzoate (4 grams daily) are not injurious to health, and are not poisonous in the general sense of the term. In certain ways they exercise a slight action over certain physiological processes, the exact significance of which is not determined.

3. Addition of sodium benzoate in large or small doses to food exercises no injurious influence on the quality or the nutritive value of the food.

The changes in certain physiological phenomena mentioned under 2 are concerned with the observations of Herter. In his experiments sodium benzoate in the larger doses caused a slight increase in the indigo-forming substances in the urine, a change in the bacterial-flora of the feces and a decided increase in the production of hydrochloric acid in the gastric juice.

Putting everything together, it may be stated that benzoic acid and sodium benzoate exercise a poisonous action on the organism only when given in comparatively large amounts. The constant occurrence of hippuric acid (the substance produced by the union of benzoic acid and glycocoll) in human urine leads to the conclusion that small quantities of benzoate salts arising from vegetable food or products of its oxidation, are always circulating in the blood. One may conclude from this as well as from the experiments of the American Commission, that benzoic acid in amounts up to 0.5 gram distributed in small doses during the day are harmless to the human organism. Whether larger doses (amounts of several grams) can be constantly taken by all individuals with the same impunity can not now be stated. The experimental work of the American scientists in this particular was not continued long enough and their conclusion was associated with certain reservations, so that it can not be considered as affording the proof of absolute harmlessness.

For this report consult *Zeitschrift für Untersuchung der Nahrungs- und Genussmittel,* Bd. 22, p. 261, July 15, 1911.

With regard to the common origin of the garbled extracts of the Prussian Deputation's Report furnished to the American press, let the following sorrowfully be recorded:

The report made by the health officials of Germany on the use of benzoate of soda in foods and which sustains the position originally taken by Dr. Wiley, of the United States Bureau of Chemistry, and is antagonistic to the position taken by the Remsen Board, has been transmitted to the Agricultural Department by the officials of the State Department.—*Oil, Paint and Drug Reporter,* October 16, 1911.

and,

Until a question is settled right it will never stay settled, and the benzoate of soda controversy seems to be one of these questions. The latest to have a word on the question is the Scientific Deputation for Medical Affairs in Germany. . . . This deputation has taken the tests made by Dr. Wiley at their face value, thus confirming the stand taken by those in this country who would prohibit the use of benzoate of soda in all food products.—Government Agricultural Experiment Station, Agricultural College, N. D. *Special Bulletin,* Food Department. Vol. I., No. 36, September, 1911.

and,

The American public believes that a question is not settled until it is settled right. . . . Of the decision of the United States referee board, these German scientist say: "The series of experiments in this connection made by the American scientists are of too short duration and the results coupled with certain limitations, so that they can not be regarded as demonstrating the unconditional non-injurious nature."—*Journal of the American Medical Association,* Vol. XLVII., No. 19, November 4, 1911.

GRAHAM LUSK

A FEW MATHEMATICAL ERRORS IN THE RECENT EDITION OF THE ENCYCLOPÆDIA BRITANNICA

As a large number of students do not have easy access to extensive special literature, they are led to regard general works, such as the Encyclopædia Britannica, as the supreme authority on many questions. It may, therefore, be of interest to call attention to a few conspicuous errors in the new edition of this excellent work. On page 857 of volume 19 (1911), we read as follows: "What is quite certain is that our present decimal system in its complete form, with the zero which enables us to do without the ruled columns of the abacus, is of Indian origin." How far this is from the truth may be inferred from the following paragraph.

During the meetings of the second international congress of mathematicians held in Paris in 1900 the eminent German mathematical historian, Moritz Cantor, expressed the opinion that the use of zero was probably discovered by the Babylonians about 1700 B.C.[1] In the third edition of volume I. of his classic "Vorlesungen ueber Geschichte der Mathematik," 1907, page 616, Cantor remarks that according to his opinion the discovery of zero is due to the Babylonians, while the deepening (Vertiefung) of the concept is due to the Hindus.

A more decided error is expressed on page 626 of volume 12, in the following sentence: "The technical mathematical sense (of the term group) is not older than 1870." It is surprising that such a statement could emanate from the country where Cayley worked and developed the foundations of abstract group theory as early as 1854. It is well known that Galois (1811–32) was the first to use the term group as a technical mathematical term, with its present significance, and that Cayley and Kirkman employed this term with its technical mathematical sense in a number of articles, published before 1870, in the *Philosophical Magazine* and in the *Memoirs* and *Proceedings* of the Literary and Philosophical Society of Manchester.

[1] *Bulletin of the American Mathematical Society*, Vol. 7 (1900), p. 70.

Closely related to the error noted in the preceding paragraph is the following, which appears under the word *Galois:* "To him (Galois) is also due the notion of group of substitutions." While the technical mathematical term group is due to Galois, as we observed in the preceding paragraph, the *notion* of group is very much older. According to Frobenius and Stickelberger, the theory of finite abelian groups was founded on the one hand by Euler and Gauss, and on the other by Lagrange and Abel; and, according to Poincaré, the principal foundation of Euclid's demonstrations is really the existence of the group and its properties.[2] No one acquainted with the history of group theory would say that the *notion* of group of substitutions was due to Galois.

In the first volume of the Encyclopædia Britannica under the term *abscissa* we find the following incorrect statement: "The word (abscissa) appears for the first time in a Latin work written by Stefano degli Angeli (1623–1697), a professor of mathematics in Rome." As early as 1903 C. R. Wallner pointed out in the *Bibliotheca Mathematica*, page 37, that the statement in Cantor's "Vorlesungen ueber Geschichte der Mathematik," which might furnish the basis of the error under consideration, is incorrect. In a recent part of the Encyclopédie des Sciences Mathématiques, tome 3, volume 3 (1911), page 1, G. Eneström points out that the origin of the word abscissa goes back to the Latin translations of the "Conic Sections" by Apollonius, written in the third century before Christ. Eneström gives, at this place, numerous references in regard to the early use of the term abscissa.

Another incorrect statement appears in the article on number theory, volume 19, page 851, and reads as follows: "By totient of n, which is denoted after Euler by $\phi(n)$, we mean the number of integers prime to n and not exceeding n." While Euler studied some of the properties of the totient of n he did not use the symbol $\phi(n)$. This symbol, as far as we know at present, was first used by Gauss in article 38 of his "Disquisitiones Arithmeticæ,"

[2] *The Monist*, Vol. 9 (1898), p. 34.

1801. The function of n represented by $\phi(n)$ is, however, generally called Euler's function, since Euler had studied some of its fundamental properties before the appearance of Gauss's "Disquisitiones."

It is a well-known fact that it is easy to find errors in nearly every book and the few errors noted above would be of very little interest if they did not occur in such an excellent work. As they were met incidentally, it is not implied that they include the most important mathematical errors in the work under consideration. They may perhaps serve to emphasize the great importance of a thorough study of the question on hand before expressing a definite conclusion, and also the large amount of labor involved in such a study. There is a vast amount of error afloat even in the best literature of the present time, and this calls for a larger army of workers who investigate questions *ab initio* and who are fearless in resisting the tendency towards the further spreading of these weeds on the intellectual earth.

G. A. Miller

University of Illinois

MORE WASHINGTON SCIENCE

To the Editor of Science: I have been reading with much interest the recent communications on Washington science. No one will deny credit to the scientists who are giving the government department their best energies. Still, these same men are occasionally lacking in—I am almost tempted to say a system of professional ethics. I have been quite near the inside of Washington methods and herewith present the case.

In the event of choosing a scientific assistant for a vacancy, I have known in several cases that the matter of minimum salary the applicant would accept was of paramount importance while the ability and training of the applicant seemed to be an insignificant matter. I know cases where men with practically no college or scientific training of any sort were preferred to college graduates with experience, because the former could be obtained for five dollars a week less. I know a case in one division where $100 per year represents the difference between the beginning salary of an untrained man and that of a post-graduate of a large eastern university. I do not refer to men appointed under the civil service competitive examination, but rather to those who come under the general heading of agents and experts, who are appointed merely at the recommendation of a division chief. Many of us know of cases wherein good men were discouraged, by this state of affairs, to the extent of entering other lines of endeavor. It is now in order for some one to sign an earnest communication containing the phrases "love of science," "mercenary," etc. To one interested in this subject I would suggest looking up the records of resignations of very good men from the government bureaus as a result of the order of Secretary Wilson (1909) that no promotions were to be made for the next fiscal year. Is there not a system of ethics in these matters?

For obvious reasons, I emulate my predecessors and sign myself

A Former Washingtonian

COLUMBIA AND BERLIN

A statement has recently appeared in a number of newspapers to the effect that Columbia University having passed the University of Berlin in attendance is now the largest university in the world. As a matter of fact it will probably be several years before the attendance at Columbia exceeds that of Berlin. The error in calculation has arisen primarily from the fact that the Columbia figures include not only the fall attendance but also the enrollment of the summer session of 1911, proper allowance, of course, being made under duplication for the summer session students who returned for work this fall. The figures of the University of Berlin, with which a comparison has been made, include, however, only the attendance during the winter semester, the summer semester enrollment not being considered. Inasmuch as registration at the University of Berlin for the winter semester of 1911–12 is not yet completed, it is simpler to make a comparison between

the attendance at Columbia University during the academic year of 1910–11 and the attendance at Berlin during the winter semester of the same year, leaving the summer session students out of consideration in both cases.

There were matriculated at the University of Berlin last winter, 9,686 students, distributed as follows: Protestant theology, 406; law, agriculture and forestry, 2,429; mêdicine, pharmacy and dentistry, 1,864; philosophy, pure science, etc., 4,987. In addition 778 men and 256 women were enrolled as auditors, so that the total attendance amounted to 10,720, this being exclusive of 4,664 auditors registered at other Berlin schools of university rank. Leaving the auditors out of consideration, the University of Berlin had an attendance last winter of 9,686 students, as against Columbia's 5,893, the latter being distributed as follows: undergraduates, 1,349; theology, —; law, 376; medicine, 329; pharmacy, 275; applied science, 724; architecture and music, 182; political science, philosophy and pure science, 1,367; Teachers College, 1,571 (280 duplicates). Of the 1,349 undergraduates, 839 were enrolled in the freshman and sophomore classes, and these students in Germany would correspond to the two last years of the secondary schools—*i. e.*, they would not be of university grade in Germany. Omitting these students, the total would be reduced to 5,054. Then if we subtract the enrollment of Teachers College, the faculty of applied science and the faculty of fine arts, we would have compared with the 9,280 students enrolled at Berlin in the various faculties, exclusive of theology, only 2,857 students at Columbia. The number of students in agriculture, forestry and dentistry at Berlin—departments not represented at Columbia—is not large enough appreciably to affect the result. The law and medical schools at the University of Berlin are each about five times as large as the corresponding schools at Columbia, and the Berlin non-professional graduate students are more than three times as numerous as they are at Columbia. It must also be borne in mind that in general the requirements for admission to the professional schools, with the exception of law and medicine, are—with few exceptions—higher at Berlin and other German universities than they are at Columbia and elsewhere in the United States.

In the same year the University of Munich had an enrollment of 6,905 students, exclusive of auditors, and Leipsic had an enrollment of 4,900 students, so that the former at least may be regarded as being larger than Columbia, no matter from which standpoint the matter may be viewed, and from certain viewpoints Leipsic is larger. The latter university, in addition to its 4,900 matriculated students, had 904 auditors, and it might thus also be considered as outranking Columbia in size. If the summer semesters for Berlin, Munich and Leipsic were added, the numerical superiority of these institutions over Columbia would become even greater, for as against Columbia's 2,632 summer session students in 1910 and 2,970 students in 1911, there were registered at the University of Berlin in the summer semester of 1910, 7,383 matriculated students and 651 auditors; at Munich there were 6,890 matriculated students and 474 auditors; and at Leipsic 4,592 students and 784 auditors. These figures are all based on reliable statistics compiled annually for the "Deutscher Universitäts-Kalender."

I might also add that compared with the 724 students enrolled at Columbia in the faculty of applied science during the academic year 1910–11, there were 2,168 students registered at the Berlin School of Technology in the winter semester of 1909–10, these students of course not being included in the enrollment of the University of Berlin.

It is also well to remember that Berlin is not the largest university in the world, this distinction belonging to the University of Paris, at which there were enrolled during the winter semester of 1909–10 no fewer than 17,512 students. At the University of Cairo there were over 10,000, at Moscow over 9,000 matriculated students, at St. Petersburg almost 9,000; at Vienna there were 6,833 matriculated students in the summer semester of 1910, at Budapest (Hungary) there were 6,683 matriculated students in the winter semester

of 1909–10; at Naples there are almost 7,000 students, and at Tokyo over 5,500.

It will probably be some time before Columbia University—in point of student enrollment the largest American university—or any other American university attains to the distinction of attracting the largest student body in the world to its halls; and in the meantime it is well to bear in mind that, after all, greatness and not bigness is the most important factor in the development of our higher institutions of learning, and that the Columbia authorities lose no opportunity to emphasize the value of quality in contradistinction to quantity. RUDOLF TOMBO, JR.

COLUMBIA UNIVERSITY

SCIENTIFIC BOOKS

The Doctrine of Evolution: its Basis and its Scope. By HENRY EDWARD CRAMPTON, Ph.D., Professor of Zoology, Columbia University. New York, Columbia University Press. 1911. 12mo, pp. ix + 311. $1.50 net.

The difficulties of presenting scientific conceptions and results in wholly untechnical language are abundantly evidenced; they are appreciated by every one, most keenly by those who have attempted the task. Failure to achieve such a purpose seems to follow more often from falling away from the strictly scientific method and spirit, than from an inability to make facts passably intelligible.

To Professor Crampton, however, must be granted a large, if not a complete, measure of success in his attempt thus to set forth the essentials of the evolution idea. For the lucidity of his untechnical statements of facts makes his work thoroughly intelligible, while his method and the scientific spirit which pervades the work make it convincing.

This volume consists of the Columbia University Hewitt Lectures for 1907. As such they were prepared for an audience "of mature persons of cultivated minds, . . . quite unfamiliar with the technical facts of natural history." All consideration of the work must obviously be made with the nature of its adaptedness constantly in mind: it is intended as "a simple message to the unscientific."

The introductory chapter provides a setting for the evolution doctrine and includes a brief discussion of certain fundamental principles of science in general, and in particular of biology. There are the necessary descriptions of the biological sciences, of the nature of the organism, and of life processes, throughout which the wisdom of the author is evidenced by his discreet avoidance of the word "vitalism" in any of its present meanings. The second and third chapters are given to setting forth the evidences of evolution as afforded by the structure, the development, the fossil history and the geographical distribution of organisms. Factors in the process of evolution are reviewed in the fourth chapter. This concludes what might have been termed Part I. of the work, dealing with general evolution.

In the remaining chapters the author takes up various phases of human evolution for especial emphasis and more detailed treatment. Presentation of the facts regarding the "physical" evolution of the human species is followed by an account of the evidences for the evolution of the human races. This leads to an account of man's mental evolution, which is discussed from the standpoints of comparative psychology, both descriptive and genetic, of "comparative anthropology," and of the "paleontology of mind."

It is at this corresponding point that many somewhat similar accounts of evolution terminate. Professor Crampton, however, does not fail to discuss those aspects of the evolutionary doctrine which the general reader to-day regards as of the most importance, and concerning which there is the greatest need for simple, sane, scientific treatment. For there follow two chapters entitled "Social Evolution as a Biological Process" and "Evolution and the Higher Human Life." Many will find these the most valuable parts of the book, for here are reviewed, in simple terms, the fundamental evolutionary aspects of social relations, and of ethics, religion and philosophy.

In its general plan this work is not unlike

the valuable series of Romanes. Throughout it is conservative, perhaps ultra-conservative in its treatment of such topics as the biogenetic law, the heritability of modifications, and some other general subjects. And it is thoroughly orthodox; the giraffe and the blacksmith are not found wanting.

The entire American Museum of Natural History would be required adequately to illustrate so inclusive a theme as this. And the complete absence of figures, which were abundantly provided for the lectures themselves, is a serious defect. The capacity, even of the careful reader, for misunderstanding language, is enormous. Even a few well-selected figures would give the reader a frequent sense of definite concreteness which is occasionally lacking in some of the passages dealing with the facts of evolution.

There is no index.

It is safe to say that this book will prove immensely useful, and its use will not be limited to the unscientific. Students of biology and sociology will find it a valuable aid and summary. In marked and agreeable contrast to Romanes's work, it is entirely free from controversial tone, and its excellent spirit, so well evidenced by the concluding chapters, will go far toward making the doctrine of evolution completely acceptable to those who still persist in exempting from evolutionary treatment and understanding, certain large and important fields of human action and thought.

W. E. Kellicott

Guayule, a Rubber Plant of the Chihuahuan Desert. By F. E. Lloyd. Carnegie Institution of Washington, Publication No. 139. 1911. Pp. viii + 213. Plates 46, text figures 20.

It is seldom that the results of a critical study of one plant from several different viewpoints are brought together at one time within the covers of a single book. The author of Guayule has, however, collected many facts relating to the growth and utilization of *Parthenium argentatum* Gray, which are worthy of notice. The interest in the present work from the scientific standpoint is enhanced by the fact that the subject of the investigations is a native of desert regions relatively little known botanically or ecologically. From the economic standpoint it is of interest as furnishing a record of a plant of peculiar importance commercially, whose life history and habits were hitherto practically unknown, though subjects of abundant speculation and conjecture.

The first chapter presents a brief historical account of the Guayule and its use. The writer traces the development of the industry and describes some of the methods of extraction, which in this case are based upon the fact that the rubber is not produced in latex which issues from incisions in the bark, but is obtained only upon trituration of the stem, branches and roots of the plant. Involving, as it does, the immediate destruction of the whole plant, the manufacture of Guayule rubber is attended by the prospect of an early depletion of the natural supply. Hence investigations were begun looking to the placing of the enterprise upon a permanent footing.

The environment of Guayule and its biotic relations are discussed in the second chapter. *Parthenium argentatum* is distributed widely over the Mexican plateau and on hills whose soil is chiefly of limestone origin. Its altitudinal distribution is from 2,000 to 10,000 feet, though mostly from 5,000 to 6,000. The local distribution of the plants and the extent of their numerical development were carefully studied by the author, who is unable, however, to explain the almost total absence of Guayule in the alluvial soil of the broad playas. He suggests that this fact may be due to the meager aeration of the soil of the playa, and to the possibility of a slight acidity, owing to the presence of a slight quantity of humus. The reviewer has obtained results[1] that seem to show that the mechanical conditions of a fine alluvial soil are not unfavorable to the growth of Guayule. But on the other hand it should be noted that the quantity of water-soluble salts is less in

[1] *American Review of Tropical Agriculture*, May–June, 1910.

the native soil of the Guayule than in the alluvium of the garden, where the experimental grounds were located, which resembles the soil of the playa. It would, moreover, seem unlikely that acidity exists in this soil in the presence of carbonates. At all events the greater concentration of the salt solutions in the soils of the lower plain, as a possible additional factor affecting the distribution of Guayule, is well worth consideration. This conclusion is supported by the fact that the alluvial soil proved inimical to the growth of seedlings, a fact which Professor Lloyd elsewhere recognizes, and that this was not due to mechanical conditions alone has been demonstrated in carefully conducted experiments.[1] Some of the alluvial soil used was fatal to the Guayule seedlings at first, but after leaching offered no obstacle to their development (page 68), additional evidence that the salt content is in this case an important factor.

Discussing the subject of the size and form of the Guayule plant, the author states the upper limit of weight to be about 5 kilos and of height to be about one meter. The mature plants are profusely branched, the leaves and younger twigs being clothed with a silvery pubescence. The root-system, distributed chiefly through the superficial layers of the soil, is partly concerned with the usual work of absorption and partly with the function of vegetative reproduction, accomplished by long, slender members from which arise shoots called retoños. The identification of two biotypes is a matter of special interest. As to whether there were two distinct forms of the Guayule was a subject frequently discussed at Cedros. Observers sometimes remarked two forms of the plant, yet when an effort was made to delimit the characters of the two forms definitely, their distinctive marks seemed quite elusive. It would seem that the author of the present paper has happily discovered the line of cleavage.

Under the topic of reproduction the function and importance of the retoño is discussed at length. As a means of reproducing a stand of Guayule the retoño is not found to be very effective. Regeneration of the stand is brought about much more rapidly by cutting off the shrub instead of pulling it up in the harvesting process. Reproduction by seed is slow and only takes place at all on open ground under the most favorable conditions. The author concludes that a ten to fifteen year rotation is practically possible and economically advantageous, the average rate of height growth being about 3 cm. per annum.

The chapters on the anatomy of the plant (V. and VI.) present a detailed description of the structure of the young and mature plants in root, stem and leaf. In this connection it is interesting to note the effect of irrigation on the relative development of wood and bark. The volume ratio of bark to wood in the irrigated plant is near to unity in the smaller twigs to 0.27 in the larger, up to 13 mm. in diameter. In field plants the ratio for the smaller twigs approaches 2.5, being reduced to 1.7 for stems 13 mm. in diameter and approaching unity in those larger. On the other hand, in point of age the ratio of total bark produced in the irrigated plant to that of the field plant of the same age is about 5.6.

On the origin and occurrence of rubber (chapter VII.) the author informs us that 9.5 per cent. of the dry weight of the shrub is rubber. This is distributed through the pith, medullary rays and inner bark. The quantity of the rubber secreted and the time of secretion stands in relation to the water available and the seasonal activity of growth. Very little rubber is secreted during the period of active growth, and relatively little at any time in irrigated plants, but secretion proceeds more rapidly with the advance of the dry season. The function of the rubber in the economy of the plant seems obscure.

The concluding chapters deal with the experimental operation on vegetative reproduction, with seeding, and with proposed methods of cultivation. The author takes a hopeful view of the possibilities, and believes the solution of the problem of successful propagation not to be beyond the limits of practicability. From the evidence adduced it would seem that this may be possible, but the evidence also seems to point to the conclusion that an ade-

quate conservation policy with reference to the harvesting of the native crop is immediately imperative, and that it will also doubtless avail more for the perpetuity of this resource than any attempts at plantation methods.

It is to be regretted that the author has not considered in this connection the cost of the operations, upon which must depend, of course, the practicability of propagation. Since field seeding seems impracticable, except under the most extraordinary conditions, the procedure must take the form of nursery methods, involving considerable outlay in labor and equipment. Without discussing the details, for which space can not be taken here, it may suffice to say that the cost involved in these operations, computed on the basis of conditions at Cedros, seems quite prohibitive.

In conclusion, the admirable quality of this contribution should be recognized. Though lacking completeness in parts, as the author himself admits, there are in this work, nevertheless, the abundant results of careful and painstaking research. The magnitude of the accomplishment is the more apparent to the reviewer, as one familiar with the difficulties and discouragements which beset its author during the year upon the hacienda.

J. E. Kirkwood

Les syénites néphéliniques de l'Archipel de Los et leurs minéraux. By A. Lacroix. Extrait des nouvelles archives du Museum, Series 5, Vol. III. Paris. 1911. 4to. Pp. 132, 10 plates and text illustrations.

In any work from the fertile pen of M. A. Lacroix we are accustomed to expect the thoroughness and accuracy that distinguish the present petrographic study on the nephelinic syenites of the Isles of Los off the coast of Guinea. This group of islands was ceded to France by the Anglo-French convocation of 1904.

M. Lacroix signalizes the interesting fact that the geological formations of the Guinea coast differ radically in their chemical composition from those of the nearby Isles of Los (p. 8). In the nephelinic syenites constituting Rouma (Crawford) Island, lavenite and astrophyllite are constant constituents, often present in as great quantity as ægyrite, all being distinguishable without the aid of the microscope; sometimes one and sometimes the other of these constituent minerals predominating. When these rocks contain arfvedsonite, occasionally accompanied by a little biotite, this amphibole forms crystals which may attain a length of several centimeters. In addition to the elements above noted, villiamite may also be found as well as fluorite and pyrochlore, both in microscopic quantities; more rarely eudialite is observable. To them may be added several secondary minerals. The author finds in the fact that the låvenite is often formed after the feldspars a typical quality of these rocks, this constituent being usually a primitive constituent in rocks of this kind, although analogous conditions have been observed in nephelinic syenite from the Ord Range in Texas.

The syenites of the Isles of Los are divided by the author into the principal petrographic groups, whose close relation to one another is brought out by chemical examination. One of them, more alkaline and containing little or no lime or magnesia, is constituted by the syenites with ægyrite; the other, but a trifle more calciferous, includes the syenites with black amphibole and augite, and the alkaline monzonites where plagioclase exists.

The characteristics of these two groups and those of the minerals found in the syenites are very fully described. Among the minerals found in the first group are the following: feldspars, either sodium orthoclase (Rouma, Kassa), or microcline (Rouma, Robané); they especially abound in the pegmatites of Rouma; nepheline occasionally occurring in crystals five centimeters in length; sodalite, a light yellow shade of this mineral, abounds in the normal syenite of Rouma Island; in the pegmatites the soldalite occurs in crystals three centimeters long and of a light yellow, or a lavender blue color, greenish in places, ægyrite-acmite; the ægyrite sometimes approaches to acmite, while in some specimens of syenite from the northern part of Kassa Island only acmite is found; asfredsonite, oc-

casionally appearing in small acicular crystals with or without biotite, resembling those found in Norway and Greenland; låvenite, one of the most constant minerals of these rocks, and the most notable colored mineral of the rocks at Rofare, the small crystals being remarkably well defined, with intense polychroism; the author believes that these nephelinic syenites of the Isles of Los are those in which låvenite occurs most abundantly; rinkite; astrophyllite, constant in the syenite of Rouma Island, but only exceptionally found in that of Kassa Island; biotite, not often met with, sometimes perpendicularly impaled on the surface of crystals of magnetite; eudialyte, occasionally showing metamorphosis into catapleiite; villiamite, named by M. Lacroix after his faithful collaborator, M. Villiaume, a mineral characterized by an intense polychroism; fluorite, colorless, pink or light violet; pyrochlore, particularly abundant in the normal syenites of Rouma Island; galena; analcite, which the author regards as formed in a pneumolithic phase and not a product of decomposition; hydrophyllite; mesotype; losite and a number of other minerals. Many of these are present in the second group of syenites in addition to zircon, titanite, titanomagnetite, woehlerite, etc.

Chemical analyses of a number of specimens of the syenite are given and the examples shown in the plates are very fully elucidated. We have only been able to note a few of the more important data contained in this stately, valuable contribution to petrography by France's greatest petrographic geologist.

GEORGE F. KUNZ

Ka hana kapa: The Making of Bark Cloth in Hawaii. By W. T. BRIGHAM, A.M., Sc.D. Memoirs of the Bishop Memorial Museum of Polynesian Ethnology, III. Honolulu, Museum Press. 1911. 4to. Pp. 273; 48 plates and atlas of 26 colored plates.

It is well known to ethnologists that among the few living men having personal and scientific knowledge of the ethnology of the Hawaiian Islands, the director of the Bishop Museum stands unrivalled. During the period in which that museum has engaged in publication a succession of memoirs has proceeded from his pen, in which a vast amount of otherwise unwritten Polynesian lore is fortunately preserved. The present volume is devoted to the history and description of the bark cloth, tapa or kapa, of the Polynesians, a manufacture which reached its greatest perfection in Hawaii, and which, on the coming of the white man, with woven cloth and figured calico, deteriorated and soon practically ceased. Museum specimens alone preserve for us the actual material, on which Hawaiian art and fancy were so lavishly expended.

Dr. Brigham gives us first the history of its manufacture as described by the earliest voyagers, from Hawaii to Madagascar, the Philippines, and even Africa; then an account of the dyes and tools used; botanical descriptions and figures of most of the plants and trees from which the raw material was obtained; the uses of the finished product; the designs used in its ornamentation; a vocabulary of kapa terms, lists of the material studied in the various museums and in his own private collection, with numerous illustrations in the text; and finally an atlas of beautifully executed plates in color, reproducing the exact designs, with many black and white plates illustrating simpler variations, both from Hawaii and other regions where the art was practised.

Dr. Brigham and the trustees of the museum are to be congratulated on the appearance of this splendid monograph which preserves for posterity a wealth of information, much of which might, and indeed probably would, otherwise have been lost to the world in the course of a few years.

WM. H. DALL

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION

THE Smithsonian Report for the year 1910 has just been published by the institution. Besides the report of the regents and the secretary, the volume contains, as usual, a "General Appendix" consisting this year of

thirty-four papers of popular interest on various branches of science, also biographies of a number of prominent scientific men who have recently died. Some of the papers are original, while others are reprinted from foreign and domestic scientific and technical periodicals. The following statement of the contents has been sent from the institution.

A review of modern progress in aviation is ably recorded by the late eminent aeronautical authority, Mr. Octave Chanute. His paper covers the principal advances made in aviation, beginning with the experiments of Hiram Maxim in 1894, and including Langley's experiments, 1896–1903, the author's own investigations, the work of the Wrights, Dumont, de Lagrange, Farman, Bleriot, Bell, Curtiss and others, bringing the subject down to the close of the year 1909. Altogether it is a most interesting review, illustrated with 19 plates and several text figures.

Mr. F. H. Newell, director of the Reclamation Service, sets forth the recent progress in the reclamation of the arid lands in the western states. The work of reclamation includes all the western states and territories, where nearly 10,000 families are being supplied with water. Through this great undertaking, the waste waters of the west are being conserved, destructive floods prevented, apparently valueless lands converted into productive farms, and thousands of families settled in newly opened territory where they are maintaining homes on reclaimed land. Besides engineering with its business and financial problems, the article deals with many other subjects, such as the character of settlers, the size of farms, crops, etc., and the individual projects which together furnish water for about 1,000,000 acres, nearly one half of which is already settled.

A kindred topic is the great electric power plant at Keokuk, Iowa, with its 4,278-foot concrete dam across the Mississippi River between Keokuk, Iowa, and Hamilton, Ill. This subject is treated by Mr. Chester M. Clark, in a well-illustrated article entitled, "Electric Power from the Mississippi River." The paper shows the development of the largest single hydro-electric plant in existence, through the construction of what is undoubtedly the greatest bank-to-bank dam in the world.

Under the heading of physics, Dr. T. Thorne Baker has written an account of experiments and researches in the telegraphy of photographs, transmitted by both the wire and the wireless systems; Mr. Jean Becquerel, professor at the Museum of Natural History of Paris, has permitted the translation of his valuable paper on "Modern Ideas on the Constitution of Matter," comparing the old theories of matter with the newer ones recently confirmed by experiments; and Professor R. A. Millikan has abridged his treatise on "The Isolation of an Ion," which deals with the exact measurement of an elemental electrical charge and several analogous problems.

On the testing of explosives, Dr. Charles E. Munroe, professor of chemistry at George Washington University, and a well-known authority on explosives, has written an interesting paper on the "Modern Developments in Methods of Testing Explosives."

Charles G. Abbot, director of the Astrophysical Observatory of the Smithsonian Institution, contributes an article on the recently developed subject of astrophysics, which is a study of celestial physics, but pertains principally to the heat and other physical properties of the sun. The paper relates to "The Solar Constant of Radiation," a topic on which Mr. Abbot is well informed, having pursued studies in that direction for nearly sixteen years, at the Smithsonian observatory in Washington, and on Mount Whitney and Mount Wilson, California. In this article the author deals with the problem of measuring the amount of solar heat received by the earth and that lost in transit to it, and the reader finds himself amazed at the obvious facts and reasonable possibilities depending upon the heat from the sun. The subject of astrophysics is further treated by Messrs. Curtiss, Deslandres and Bosler, in three timely articles.

Under the title "What is Terra Firma?" Mr. Bailey Willis, of the U. S. Geological Survey, attacks the old, yet modern, problem of the construction and balance of our globe,

in a review of current research in what is known as "isostasy." In the discussion of this puzzling question, Mr. Willis advances the theory that the foundation of all the continents is composed of solid rock which is self-crushed to a depth of about 120 kilometers, but rendered sufficiently rigid by pressure to maintain its form during prolonged geologic periods with but slight change. In spite of stresses occasioned by erosion of continental reliefs, this mass is capable of movements sometimes resulting in the gradual elevation of continents and the more vigorous uplifting of mountains, through which isostatic equilibrium is restored.

In line with the construction and condition of the globe, another author, Professor Thomas Chrowder Chamberlin, brings up the further vital question, "The Future Habitability of the Earth," in an article in which he reviews the past, and considers the future, of the world as a dwelling place for the human race. Many branches of science enter into the discussion, but upon geology, physics, chemistry, astronomy and astrophysics rests the burden of the arguments. Mr. Chamberlin thinks that the earth will remain habitable for tens of millions of years, but concedes that the close approach of a celestial body to the sun would probably result in the disruption of the solar system and bring disaster to the earth. He further states, in regard to the future possibilities of scientific research, that "when moral purpose and research come to be the preeminent characteristics of our race by voluntary adoption and by the selective action of the survival of the fittest, and when these most potent attributes join in an unflagging endeavor to compass the highest development and the greatest perpetuity of the race, the true era of humanity will really have been begun."

Several papers come under the head of botany, among them an interesting sketch of the sacred ear-flower of the Aztecs, a plant whose identity has been a mystery for years and only recently rediscovered by the author, Mr. W. E. Safford, of the Bureau of Plant Industry. This little flower, resembling the human ear, has a remarkable history and dates back to the early explorations of Mexico. It was first described in 1569, by Padre Bernardino de Sahagun, who states that it was much used owing to its delicious fragrance and its flavor when used as a spice. Despite the formidable name, Xochinacaztli, which it bears, the author suggests its cultivation on account of its unusual fragrance and pleasant spicy flavor. Mr. Henry S. Graves, chief of the Forest Service, contributes a well-illustrated and original article on forest preservation, in which he carefully considers all points in the great problem, making many things clear which have long been obscure.

Those interested in medical research and allied subjects will find matter of concern in the following papers: "Manifested Life of Tissues Outside of the Organism," by Alexis Carrel and Montrose T. Burrows; "Epidemiology of Tuberculosis," by Robert Koch; "The Significance of the Pulse Rate in Vertebrate Animals," by Florence Buchanan, D.Sc., and "Sanitation on Farms," by Allen W. Freeman, M.D.

A comprehensive paper on the contemporary Slav peoples, from a geographical and statistical point of view, by Ludor Niederle, of the Bohemian University of Prague, which has been translated from the Slavic language into English, furnishes new information on the history and distribution of these peoples. Dr. J. Walter Fewkes, of the Bureau of American Ethnology, contributes a brief review of his recent work and investigations in cave dwellings, both at home and abroad. This paper is entitled "The Cave Dwellings of the Old and New World."

The Report also contains biographies of Melville Weston Fuller, Sir Wm. Huggins and Alexander Agassiz, together with papers on several other subjects treated by competent authors, many of whom are world-wide authorities.

SPECIAL ARTICLES

CESTODE CELLS IN VITRO

THE desirability of throwing any light whatsoever upon the question of the character of

cell-division in cestode cells prompted me to attempt to apply the method of Harrison[1] in growing neurones, to cultures of cells from the tape-worms which are available from the spiral valve of the dog-fish, sand-shark, the cystic duct of the squeteague, etc. Inasmuch as sand-sharks were obtained only infrequently during the summer of 1911 at the Marine Biological Laboratory, Woods Hole, Mass., I was forced to depend upon the small *Calliobothrium* of the dog-fish, rather than upon the larger and more desirable *Crossobothrium* of the sand-shark. The form in the squeteague was not obtained in sufficient numbers to be of much use in the experiments.

I was directly led to the attempt of growing the isolated cells of the tape-worm from an examination which Dr. Frederic M. Hanes and Dr. R. A. Lambert kindly permitted me to make, of a series of their preparations of mouse sarcoma cells growing *in vitro* at the College of Physicians and Surgeons, New York. The marked success which they experienced[2] along this line, where the cells grew out from the small pieces of tissue from the living mouse and exhibited amœboid locomotion, absorption of granules of carmin, presence of mitosis, etc., seemed possible in other material.

The method which was used in the present set of experiments was as follows: Slides with depressions and their covers were sterilized in a hot-air oven at 200° C. for ten minutes. Where the plasma of the blood of the dog-fish or sand-shark was used, it was centrifuged after its drainage from the caudal artery under aseptic conditions (canula sterilized in olive oil at boiling) in paraffin lined tubes surrounded with freezing mixture and the supernatant plasma was pipetted into cooled tubes which were kept in an ice box until used. The precautions taken to insure sterility were of course aimed at keeping the plasma as free from bacterial decomposition as possible and thus offer to the cells of the tape-worm as nearly isotonic a medium for growth as practicable. If *Crossobothrium* was used as material, the blood of the sand-shark was used; if *Calliobothrium*, the dog-fish blood.

The tape-worms were invariably taken from a fish which had just been killed. They were washed off in sterile sea-water, with several changes and finally teased into small bits of groups of cells which were then transferred to a drop of serum laid upon a cover-glass with a platinum loop. The cover was then mounted in vaseline over the depression. In case *intra vitam* stains were used, these were introduced at once before the preparation was sealed. Inasmuch as I was dealing with a poikilothermous animal and not with a constant temperature, warm-blodded one, as in the work of Harrison, Burrows,[3] Lambert and Hanes *et al.*, it was not necessary to keep the slides in a thermostat. The temperature, however, varied only from about 17° C. to 23° C.

The cells prepared in this manner began to migrate from the mass within twelve hours and were to be found at the end of that period, or earlier, in some cases, distributed over the whole of the culture medium. I could not observe any true amœboid motion, as evidenced by the formation of pseudopodia and the streaming of granules, but there could be no other factor operating except the locomotion of the cells as far as I could determine. It must be understood that the cells are very small, and exhibit a marked degree of refraction, as is the case with all of the cestodes and even if blunt pseudopodia were formed, they would be observed only under the most favorable conditions, while probably protoplasmic streaming would be impossible to see. Moreover, when the plasma of *Limulus* was used, this distinction of cells was not observed, owing probably to the toxic action of the copper content of this peculiar blood.

Saline solutions of various content and pure sea-water were also used as media and in

[1] Harrison, R. G., 1910, *Journ. Exper. Zool.*, 9: 787.

[2] Lambert and Hanes, 1911, *Journ. Am. Med. Assoc.*, three communications.

[3] Burrows, M. T., 1910, *Journ. Am. Med. Assoc.*, p. 2057.

the latter, excellent results were obtained[4] as far as the living of the cells is concerned, but the unfortunate condition arose invariably that a large spirochæte *Spirochæte balbanii*, perhaps, grew in such numbers that the cells were soon covered with their growths and disintegration ensued. All attempts at freeing the medium from this animal, such as the use of $HgCl_2$ in various dilutions with the cestode before the tissue was teased were of no avail and the experiments in this direction were abandoned.

Difficulty was experienced in regard to the invasion of bacteria and spirochætes into the plasma mounts, but their growth for some reason was not as pronounced as with sea-water and indeed in many cases, no bacteria or spirochætes were found after ten days time. Therefore the plasma method was used throughout the experiments.

It was expected that the cells, which could be made to live in apparently good condition for several weeks in the plasma medium would undergo the process of fission and during the earlier stages of the study, I was convinced that I was observing such a phenomenon, but I finally was driven to the conclusion that what I saw was in no case cell division, but rather an association of the cells in twos which resembled a cell undergoing reproduction. I am under the impression that the cells which are cultured in this way do not undergo cell-division at all. I made charts of the slides which I had under observation for a week at a time and checked the behavior of all of the cells in each slide with camera lucida drawings, comparing those made one day with those made on the day previous. If any increase in number of the cells had occurred, I should have noticed it, of course.

In order that the cells may be stained for nuclear contents, it was necessary to take down the preparation and float the cover upon a saline solution for an hour so that the fibrin should dialyze out and I am under obligation to Professor Harrison for this technique, which is quite necessary, for otherwise the fibrin takes the nuclear stain to such a degree that the cells of the cestode become indistinguishable. Heidenhain's iron-hematoxlin, bismarck brown (used as an intra-vitam stain, as well as for fixed preparations), Ehrlich's hematoxylin, safranin and other stains were used, but all of them gave consistent results to show that cell-division was not taking place. The preparations were in some cases dried in the air or over a flame and mounted directly after staining. In other cases, the covers were inverted over osmic fumes and then passed through the alcohols into balsam.

Typical resting nuclei were seen in all of the preparations, but no indication of cell-division could be determined. It may be that cell-division occurs in rhythms as indeed is the case in *Crossobothrium* according to the results of W. C. Curtis and it may be that the period over which these present experiments extended did not cover the fission period. They were begun July 5 and extended to August 15.

In regard to the matter of regions in the cestode where fission is more likely to occur, such as the region immediately posterior to the scolex, in the "growth regions" of *Crossobothrium*, described by Curtis and in the maturing sex products, it may be said that all of these regions were examined by the methods described in this communication. No difference could be determined between the cells from one region and those from another.

While the results were unsatisfactory as far as the end desired is concerned and while they are negative throughout, it seems to me that the method may be applied to more favorable material where the character of cell-division is in question. The unmistakable presence of mitosis in the sarcoma tissue investigated by Lambert and Hanes, where amitosis has been so frequently described, is an instance in point. The "amitosis" of the follicle cells of insects is desirable and ever available material for such an investigation.

M. W. Morse

Trinity College,
Hartford, Conn.,
November 1, 1911

[4] Compare Lewis and Lewis, 1911, *Anatomical Record*, 5: 277.

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CONTENTS

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THE FUNCTION AND EFFICIENCY OF THE AGRICULTURAL COLLEGE

IT would be an indication of ingratitude and inappreciation if I failed to acknowledge at this time the great honor of being elected to preside over your deliberations, an honor commensurate with the distinguished history and eminent usefulness of this association. Because it has been my good fortune to attend these meetings from their very beginning, in addressing you on this occasion I can not be accused of speaking without knowledge and understanding if at first I refer in the spirit of congratulation to the benefits of this organization, both for those of us who have participated in its deliberations and for the institutions which it represents.

Not the least important outcome of these assemblages are the personal relations that have been established. The hand clasp that has spanned a continent has not only made possible the formation of friendships that have greatly enriched our lives, but thereby has come a sympathetic touch of laborers in the same field so essential to unity of purpose and understanding. We would all feel impoverished, personally and officially, if there were withdrawn from the sum of our life experiences the beneficent results of the intercourse that these meetings have afforded.

Because we are friends as well as coworkers, we keenly feel the absence from our midst of those who have passed out of life's activities. Two of the best beloved of our long-time associates have entered into their final rest during the year that has passed. For many years these gather-

ings were favored by the gentle and refined presence of Matthew H. Buckham, who through a long life of activity as an educator exhibited the qualities of a scholar and a gentleman. May many rise up with a similar type of mind and character to mold the intellect and purposes of coming generations! We shall not forget the kindly spirit, the manly attributes, the singleness of purpose and the efficient service of Edward B. Voorhees, whose life and activities were on a plane so high that they presented an inspiring example of useful living. The number remaining of those who aided in founding and building these new educational agencies and who are still in active service is small, and these pioneers in an undeveloped field can but feel that they are transferring to "other men and other minds" the abundant fruit of their labors.

Again, this association has been an active and most influential agency in augmenting the resources of the institutions from which you come, and in developing and unifying their administrative and pedagogical methods. Through your accredited representatives an influence, national in scope, has been focused upon legislation. The enlarged financial support of the colleges and stations by the federal government could hardly have been secured without your united effort, directed along an authorized channel. You must also recognize very clearly that your annual discussions have been helpful, even essential, to the wise solution of administrative and educational problems. Probably no other influence has been more potent in hastening and shaping the far-reaching readjustment that has been effected during the past few decades in the aims and methods of education, even in our secondary schools, than has the example and propaganda of the institutions arising from the first Morrill act, an influence to which your deliberations have served to give form and purpose.

But the main reason for extending congratulations to you at this time is the status and beneficent results of the activities here represented. It would be easy to show the marvelous growth of the equipment and work of the land-grant colleges and agricultural experiment stations by the use of statistics that are almost startling in their proportions. I shall not resort to this method, however, for you know the facts, and besides, the prominent display of such large figures savors of showy parade or of vainglorious pride. It is enough to say that as a whole these wards of the nation and states are liberally equipped as to buildings, apparatus and funds, with a disposition on the part of the state governments to provide for increasing demands in these directions; students are not lacking, practise both in agriculture and engineering is giving respectful attention to your utterances; all this indeed because after nearly five decades of strenuous and almost heart-breaking struggle, whatever have been your mistakes, you have demonstrated your right to exist and thereby have won public confidence. The colleges and stations for whose upbuilding you have labored hard and loyally are now public utilities of great importance. They are an intelligent and directive force in the conservation of our resources, both social and material. In brief, these institutions have come to be a national asset of great and permanent value.

But now that the hardships and discouragements incident to the establishment of the new and the untried are past and public confidence is won, now that you are reasonably well equipped and have the plastic minds of thousands of young men

and women with which to work your will, the time has come to ask this question: Are these agencies, established and maintained by public funds, doing work of a kind and in a manner, under the conditions which have developed, that is calculated to most fully promote public welfare? No one will deny the assertion, I am sure, that the colleges were brought into existence, not for the purpose of providing a fraction of one per cent. of our young men and women with a college education as an individual favor, but to be constructive and conserving factors in building and maintaining a strong nation. "The community has come to be convinced that education is the most competent means for the preservation and enrichment of itself." With this end in view, is their work wisely planned and directed?

A consideration of this comprehensive question requires that we bring to mind the directions along which the colleges and stations exert their influence in the exercise of their proper functions. These directions are mainly three:

1. The public relations of educational agencies.

2. The enlargement of the body of knowledge.

3. The development of the vocational and social efficiency of the individual.

It is my purpose to direct your attention chiefly to questions involved in the college training of young men and women and the development of knowledge, but I ask your indulgence while I briefly refer to the first phase of influence which I have mentioned:

As to the influence of the land-grant legislation and its results upon the public or governmental relations of educational agencies, there can be no doubt that one of the consequences of this legislation is a strong movement toward the injection of federal aid, and the federal control necessarily, accompanying the expenditure of federal money, into secondary education that so far has been exclusively supported and controlled by the states. The concrete expression of this movement is the introduction into congress of bills providing for the annual expenditure of vast sums of federal money in aid of normal schools and high schools in the various states. The policy proposed, if made effective, would have far-reaching results and for this reason it should be considered by this body in the spirit of wise statesmanship with reference to ultimate results rather than on the basis of any immediate financial advantage that might accrue to states or institutions.

It is well for us to keep in mind this law so well formulated by an educator of long experience, "that the efficiency of public education becomes the greater as the responsibility for carrying it forward is more directly and immediately felt." This admirable expression of a sound principle may be supplemented by the statement that an efficient system of public education can not be imposed upon a community by aid from without, but must be gradually developed from within.

Moreover, the broadcast precipitous distribution of public funds into localities where there does not exist the understanding and preparation necessary to their wise expenditure is sure to result in lamentable waste. This would be a less regrettable result, however, than the influence of outside aid upon the spirit of initiative and self-dependence of the people, in the absence of which no progress is made in any enterprise whatever. The school-district system once widely in vogue in the eastern states, where each political unit was practically a pure democracy, while expensive, possessed certain advantages of simplicity

and directness because of the close relation of the citizen to the school. It was a system that gave large latitude to the individual development of boys and girls and was far removed from the mechanisms of highly concentrated systems that are inelastic and attempt to force square boys and girls through round holes. While the old system would not meet existing conditions, which, for reasons of economy, require a closer organization and a fuller concentration of authority, we should avoid, so far as possible, the dangers of bureaucracy in school administration that are by no means unreal. The injection of federal aid and authority into local educational affairs could but increase the dangers to educational freedom that always attend a highly centralized administration; and, above all other considerations in importance, such a policy is in the direction of removing the citizen too far from his direct responsibility, even through taxation, for the maintenance of local institutions. The exercise of citizenship, involving as it should a discussion of public matters and a sacrifice of time and money, has great training value and is an essential means of attaining the civic efficiency necessary to our form of government. Have we any reason to doubt that the states will provide for advances in secondary education as rapidly as public sentiment, available pedagogical tools and opportunity will justify new movements? The progress already made in several states indicates that we have not.

There are those who declare that the advance of nationalism, even in the control of education, is irresistible. It is encouraging to note that there are already signs of an action against this movement. Whatever comes to pass, we should be warned that any readjustment of the relations of government to education which does not fully preserve the autonomy of the states, and to a reasonable degree, of localities within the states, in the administration of educational matters, would be repugnant to the spirit of our institutions, and a revolutionary and dangerous innovation.

I shall introduce the other phases of this discussion by the assertion that the chief and absorbing aim of the college, whether it be subsidized by private endowment or by public funds, should be the training of young men and women in a manner and to a degree that is consistent with well-recognized college standards. This statement, regarded by many as expressing an obvious truth, is given prominence in this connection not because there is any ambiguity in the language of the first Morrill act, which specifies very clearly the function of the proposed institutions, but because in recent years these colleges are moving with accelerated momentum towards agricultural activities, costly in time and money, that have only a remote relation to the training of their students. I refer to public addresses, farmers' institutes, reading courses, demonstration work, railroad-train instruction, fair exhibits, secondary education and similar efforts that just now seem to be increasing rapidly in volume and in their demands.

Because many of these activities are more or less spectacular and are popular in character, they certainly attract attention and stimulate interest both in the agencies which participate in them and in the knowledge which it is sought to impart. For these reasons they are very useful. Doubtless many of us upon whom is laid the burden of administering the affairs of the colleges and stations and of securing the funds necessary for their development and maintenance regard extension work of

various kinds not only as rendering a real public service, but as an efficient means of securing the public favor that insures generous support. It would be an interesting problem, psychological, ethical or otherwise, to determine in what proportions altruism and expediency enter into the motives that lie behind some of our agricultural propaganda.

But, setting aside the question of motives, there is every justification for declaring that in so far as these popular efforts, and secondary education within the college, minimize academic efficiency through the diversion or limitation of funds, through their absorption of the time and energy of teachers or through their reaction upon the atmosphere of the college and its standards of instruction, in so far the lesser is usurping the greater. It is fully recognized that this assertion is antagonistic to the view that extension work is a function of the agricultural college coordinate with, and of equal importance with, the training of young men and women, to be maintained on an equal footing as to development and permanence, and it is so meant. It may further be said that because of the strong trend towards the popularization of agricultural knowledge both within the college and station and without, because of the sweep and strength of the agricultural extension movement which is taking such diverse forms and is so largely occupying the thought and energy of college and station leaders, there has never been a more critical period in the life of the colleges and stations or a time in which their efficiency for the accomplishment of their primal and fundamental purpose should be more carefully guarded.

The gravity of the situation is augmented by the fact that the agricultural and business interests of the country, alive to the value of our worth, are now proposing to us what we shall do and are urging upon us not only efforts of our own, but our active support of new efforts that are outside our province, but to which we are expected to sustain relations of advice and aid. These suggestions, which sometimes are almost equivalent to demands, are certainly made in the spirit of goodwill and helpfulness and are always worthy of our most respectful and careful consideration, but it is seriously to be doubted whether popular conceptions of the aims and methods of education and inquiry are a safe basis on which to establish the policy that shall dominate the work and influence of either the college or station.

The chief reason that will here be advanced for directing the means and energy of the land-grant colleges along the higher ranges of educational effort is that under the conditions now existing these institutions will most fully promote public welfare by devoting their resources mainly to preparing men and women for leadership. Our social and vocational future is largely a matter of leadership. He is wildly utopian who prophesies a day when all the people, or even a majority, will possess the knowledge and ability necessary to a wise discrimination in civic and economic affairs. It is equally fanciful to hope that any large proportion of actual farmers will ever be college-trained. Secondary education must serve the needs of the great majority of the occupants of the land. In the past the reaction of the agricultural college upon public welfare has been largely through men who have become investigators, teachers, publicists and managers of large agricultural enterprises rather than through the distribution of practical farmers.

What has been true of the past seems likely to be increasingly the experience of

the future, and this fact in no way minimizes the value of the college in agricultural affairs. We ignore the teachings of all human experience if we look for the time when the destinies of the nation and the interests of agriculture or of any vocation will not be safeguarded by a small minority of citizens whose training has placed them outside the domination of dangerous sentiment and ignorant prejudice and who possess that power of discrimination derived from a knowledge of fundamental principles, without which we may not expect an intelligent and judicial consideration of either vocational or public questions.

Not only are we greatly dependent upon wise leadership in both social and industrial affairs, but with the college lies the opportunity for its development. It is among the young men and women who seek the advantages of college instruction that we find those who, because of ambition and capacity, constitute material with the largest possibilities of future usefulness. If the college fails in wisely molding these plastic minds it fails to fully occupy its one great opportunity, and if, on the other hand, the training given is inadequate or unbalanced or in any way less effective than is reasonably possible, both the receptive student and the public are defrauded and suffer a loss that can scarcely be made good.

Not all college graduates will be leaders, and not all leaders will possess a college degree; but it is a fact worthy of emphasis that the opportunity of the college is with the few and not with the many. Only a very small proportion (perhaps one or two in a hundred) of any generation of men and women will come into extended contact with college life, and these few will be the medium through which the college will render its largest and most effective service. The college can never come into efficient touch with the many as it does with the few. Whatever direct influence it secures over the general public lacks concentration and continuity; in fact, is diffuse and indefinite. Experience and observation show that a discouraging proportion of the minds reached by the attempts at popular instruction are either irresponsive or incapable and the constructive value of these efforts is not to be compared with the life-long example and influence of those who are adequately trained for social and industrial leadership.

There are those, doubtless, who believe that these institutions, supported by public funds, should stand in especially close relation to the people and that in order to do the work for which they were organized they should establish a low grade of admission, occupy a secondary place in our educational scheme, adhere closely to instruction of an ultra-vocational character and engage extensively in agricultural propaganda, leaving to the older colleges and universities the severer training that is required in preparing men and women for the higher ranges of thought and activity. It is to be hoped that if we have in any measure adopted this policy we shall move away from it as rapidly as circumstances will permit. Such a policy is a practical assumption that there is no place in the agricultural field for the highest type of intellectual development and equipment, an assumption to which no well-informed student of social and economic conditions is likely to consent. If we also take into consideration the fact that the dignity and importance of agricultural opportunities receive little emphasis in those institutions where the main trend of thought and training is in other directions, we see sufficient reasons why the agricultural college should not relegate to other agencies its clearly

indicated function—the production of the leadership that is needed for advancing the interests of the farm.

And so, because of the unsatisfied demand for adequately trained teachers and investigators, because of the complex and difficult problems related to farm life that insistently face us, so many of which are unsolved, because the redirection and upbuilding of rural-life institutions need for their accomplishment the guidance of leaders of a high order of ability, and because of the greatly increasing demand for service in these several directions which is only partially met, should we not insist that the material resources and the human knowledge at the command of the agricultural college and the plans and purposes there nourished should be directed toward sound inquiry and the training of young men and women for such service as will only be rendered by the few. Until we have means beyond what can reasonably be expended in increasing the efficiency of the colleges and stations is it a wise policy to assign to other purposes funds that should be applied to securing and holding teachers and investigators of large attainments and success, those who are masters in their special fields? Agriculture needs more of such men and should be able to create for them a favorable environment for their work.

And we now come to a question towards which this discussion has been aiming from the very first. What conditions should prevail in college instruction and what results should be kept in view in the training of young men and women for vocational and social leadership?

In considering this question we may well begin by asking what qualities should be possessed by those who are to enter effectively into the service of agriculture and country life. There can be but one answer. They are the same fundamentally that are essential to efficiency and well rounded success in any calling or profession. If the teacher, the investigator, the statesman, the lawyer or the business man should possess integrity of thought and purpose, be able to reason keenly and base their reasoning on fundamental and well-grounded principles, so should those who are to assume responsibility and leadership in agricultural affairs. There is no place for loose thinking and the empiricisms of superficial knowledge in the consideration of the economic and social problems pertaining to the open country. It is hardly conceivable, either, that the college will succeed in developing in its students these necessary qualities by any educational methods essentially different from those commended by long experience. The pedagogical tools may differ from the old ones, but the ultimate result, if it is worth while, will be those attributes of mind and character that have long been recognized as the distinctive marks of strong men and women.

As preliminary to a discussion of the conditions essential to the attainment of this result, we may safely establish certain premises on which to base any contentions that may follow. These premises, conceded on every hand, are the following: first, the subject matter of the class room should be concise and severely engage the student's mind; second, the instruction given, in whatever field, should represent the latest and best conclusions; third, this instruction, if it is to secure for the graduate an advantage over the merely practical man, must give a well-grounded acquaintance with fundamental facts and principles; fourth, the college should so react upon the young men and women that come within its influence as to develop in them high ideals of living.

There are three factors that are most

intimately related to these fundamental conditions, the teacher, the curriculum and as an outgrowth of these two that somewhat intangible influence we call college atmosphere.

What about the larger of these factors, the teacher? It should be required of him as one great essential that he be a man of scholarly spirit and attainments, and being such he should have opportunity for study and reflection. Is it not time to inquire whether we do not need a renaissance of the atmosphere of scholarship in our vocational colleges, an atmosphere that must first surround the teacher, there to be breathed in by the student? Because we have been exalting the man with a so-called practical touch, possessed of the ability to edify the farming public, through a pleasing way of discussing practical subjects or who hustles about doing things, is not our vision of the scholar as an essential factor in agricultural education and inquiry somewhat obscured, and if scholarship is to be discounted in favor of qualities that make for popularity, we may well be solicitous concerning the standards and effectiveness of agricultural instruction, a statement that is equally applicable to experiment stations as instruments of research.

It is a gross error to permit a young man, or any man, to believe that success with the people in conducting agricultural propaganda, or the possession of superficially built and glibly expressed practical knowledge, unsupported by a sound scientific training, constitutes an adequate reason why he should be a member of a college faculty or a station staff. Success in the energy-consuming activities of the institute platform, the fair exhibit, the railroad train or the demonstration field is not an evidence of fitness for class room or research work. We are guilty of a false estimate of values when we place a salary premium or any other premium on success in distributing diluted information, however valuable this effort may be, as against the function and influence of the quiet and patient scholar.

If the college is to nourish the moral character of a student, the teacher must be something more than a scholar. Character will not be much influenced by directly aiming at such a result through the teaching of ethics. Much more potent will be the general tone or atmosphere of college halls, an atmosphere that emanates from the teacher. In his hands, teaching the sciences should not only promote scientific accuracy, but should nourish integrity of thought and purpose. All the exercises of the class room should be pervaded by the ethical spirit. For these reasons the standards by which a faculty is selected should include something more than the possession of good character, and the necessary professional qualifications. The human attributes of the teacher are no less important.

We may consider certain dangers to college instruction arising from extension work. This work on the part of the college teacher is a menace to his efficiency, because such activities not only use the physical energy that should be reserved for the class room, but sooner or later they minimize or destroy the habit of study and the spirit of scholarship. The man who serves for any considerable part of his time as a purveyor of popular information is almost certain not to present to his students the latest and best knowledge in the best way, or to add much to the stock of knowledge.

Another danger to the teacher from a diversion of his thought to extension work of the popular kind is that unless he possesses unusual self-discipline and control, he will carry to the class room more or less

of the loose and dilute phraseology of platform discussion and will to a greater or less extent depart from the concise and severe terminology so essential to the best training conditions.

These are most unfortunate results. We should carefully guard and cherish the intellectual impulses and equipment of the teacher and the investigator, because they are the instruments whose edge must be fine if we are to be successful in rightly fashioning the minds and hearts of young men and women and in laying open the hidden recesses of truth.

What has been said concerning the qualities of the teacher and the necessity for defending him against the invasion of outside duties applies with equal force to the investigator. The experiment stations here represented, founded as research agencies, have rendered splendid service to agriculture and are now firmly established in the confidence of the people. Nevertheless, we should not let the popularity of these institutions cloud our vision or confuse our estimate of the real character of their work. They have mightily stirred the mass of agricultural knowledge, have conducted an extensive propaganda of existing information, have recast old facts and principles into new and profitable applications and have made some explorations of real value into the unknown, all of this to the great benefit of the farmer and his business. But the period through which we have been passing can justly be characterized as much more marked for its development of agencies and for its distribution of existing information than for its permanent additions to agricultural science.

Moreover, leaving out of account the extensive dispersion of the time and energy of experiment station workers into the highways and byways of agricultural extension and considering only our attempts at investigation, it may reasonably be doubted whether, broadly speaking, our efforts of inquiry have been conducted on a plane of spirit and method as high as that reached by the investigators of an earlier period. It may be that we have lived up to our present possibilities, doubtless we have, but whether we have or not, it is certain that unless the agencies constituted for research purposes can secure and maintain larger freedom in policy and more fully break loose from the restrictions of expediency imposed by semi-political relations and by misguided demands for popular efforts on the part of supposed investigators, we shall mostly continue to halt on the outskirts of great problems whose solution would render to agriculture the highest possible service. It is gratifying to be able to believe, however, that we are on the ascending plane in the stability and effectiveness of our research efforts.

These suggestions concerning the limitation of the activities of the teacher and investigator are not intended to be arguments against the eminently useful efforts directed toward enlightening and stimulating the public mind. These efforts should continue, but it is fair to inquire whether we have not reached a point in the development of agricultural education and the demands made upon it, where the widely distributed popular instruction and secondary education of all forms should be maintained through agencies organized especially for these purposes, to which the college of agriculture should be coordinated in an advisory relation. Extension instruction and secondary education if they are to work out the largest values, must be widely available and stimulate local initiative and activity. The college may well be a source of advice, and, when means are abundant through a corps of experts who shall be independent of other duties, it may aid in

giving the needed accuracy and direction to the knowledge that it is sought to impart. But such aid should serve to stimulate and supplement the activities of other agencies and of the various communities that are to be benefited and should be so related to the colleges as in no way to hamper their academic work.

Has not the time come when extension work should be carried on through the coordinated effort of the state department of education, the department or board of agriculture, the colleges, the normal and secondary schools, the churches, the grange, the railroads, the chambers of commerce and other business and commercial bodies, all of which should be associated in a board of direction and should contribute to a permanent and salaried faculty of instruction? There is every reason why the agricultural college should have an important place in the education of the public, but is there now any reason why it should attempt to compass the whole field or burden itself with the entire responsibility, financial or otherwise, for such efforts?

There are those who will argue, I suspect, that the closer limitation of the work of the college faculty to the higher ranges of academic training would cause these institutions to lose their vital connection with public thought and needs. We certainly have no use for a fossilized center of learning in these days when the college must be regarded as a public servant, but to prevent its petrification it is not necessary that the farmers' picnic, the grange hall, the institute platform or the railroad train shall be frequented by the teacher and investigator. These excursions from college halls may be replaced by expeditions for the careful study of social and economic conditions as they are seen on the farm and in the various business operations that are related to agriculture, with no loss, but rather a gain, in the value of the service rendered.

When an issue is raised concerning vocational curriculums we enter upon debatable ground. This audience needs not to be told that many a faculty session has been devoted to a vigorous, even heated, discussion over the relative proportions and distribution of studies in agricultural and engineering courses, for there are present many who are in the midst of a contest that is still being waged. Only general considerations concerning this much-debated matter are in order at this time.

A proper regard for a student's success in after life requires that at least three considerations shall enter into the use of his time and into the arrangement and subject matter of the course of study he is expected to pursue. These are the development of personal power, the cultivation of both the sense and understanding of social and moral obligations and preparation for vocational activity.

The development of personal power is placed first because it is the all-comprehensive factor in determining individual efficiency. It is not attained through the mere storing of information or through familiarity with technical details, for knowledge and skill are but instruments for use. It consists essentially of the power of initiative, the ability to think clearly and to reason sanely and fundamentally, and, above all, it involves that mastery of self and of the raw materials of life that lies at the foundation of all individual success.

Personal power is acquired through discipline, and so the disciplinary value of a course of study is a prime consideration. Have we not to some extent lost sight of the great and abiding truth that the intellectual and moral culture of man as a man

is the only road to either a social or a vocational uplift? In our anxiety to demonstrate the value of these institutions to the material interests of the nation, have we not over-commercialized the instruction, even the atmosphere, of our vocational schools and colleges? The leaders in engineering education are beginning to say so, and is it not true of agriculture? We may well give heed to the words of a recent writer who thus comments on the educational influence of the ancient guilds:

> The soul of this ideal education of the masses was the training of character. They had no illusions that the mere imparting of information would make people better, nor that the knowing of many things would make them more desirable citizens. In none of the higher walks of life does it ever cease to be more the question how much of a man one is, than how much he knows of his special business.

The cultivation of the sense and understanding of social and moral obligations is placed second because human relations and the quality of human effort are determinative factors in the larger successes and satisfactions of life, whether we consider the individual or the social body. It is sound doctrine to declare that, in the last analysis, the defeats of individuals and of nations are moral defeats. Moreover, we now see very clearly that the critical problems which face agriculture are no less social than vocational. Our greater weakness is not in our bread-winning capacity, but in unsound business ethics and in bad social adjustments.

And then, there is the larger relation of the educated man to national welfare. It has been said that the cure for the ills of democracy is more democracy. If more democracy is coming, and it seems to be, we shall sorely need the steadying influence of wise social leadership. The education of the masses is superficial. That keen observer, Mr. Bryce, has said that "it is sufficient to enable them to think they know something about the great problems of politics and insufficient to show them how little they know." Bishop Newman declares that "if a practical end must be assigned to a university course I say it is that of training good members of society. It is the art of social life and its end is fitness for the world." Another writer has observed that the land-grant colleges are ranked as an economic rather than a social force. If this accusation is just, these institutions should purge themselves of an unsound policy. We do violence to the highest interests of the individual and of society if we fail to cultivate in those over whom the mantle of a baccalaureate degree is thrown a sense and comprehension of their obligations to society.

It is a distorted training that emphasizes bread-winning capacity at the expense of fitness for social service. Our national welfare is already threatened by the divorcement of patriotic citizenship from industrial activity.

Preparation for vocational activity is placed last, but not because the equipment of the mind with the facts of science and their applications to the art of agriculture is in any sense unimportant. The colleges of agriculture are dealing directly with the subject matter that is related to the farmer's vocation and they will violate their obligations and limit their usefulness if they do not continue to do so.

In discussing the vocational and training value of courses of study in agriculture I shall simply be ranging myself on one side of this much debated question when I insist that these courses should present good pedagogical form and should lend themselves largely to training in the funda-

mental sciences and present the lowest feasible minimum of ultra-practical subjects.

Remarks concerning pedagogical form may not now be pertinent to any existing situation. It has been said, however, that, in the past, agricultural subjects have been taken out of the normal pedagogical order and placed among the studies of the freshman year, or otherwise distributed illogically in the curriculum, simply that a student's attention shall be held to agriculture and more graduates in agriculture thereby secured. Doubtless such transgressions are not committed now, but if they are they look very much like an attempt to lasso young men and drag them at the heels of expediency. What justification is there for invading the intellectual rights of a student or imperiling his future success by giving him less than the best possible training; and how useless such an expedient! We shall not coerce a man's choice of a life work, however hard we may try to do so. Young men will continue to enter the door that they believe opens to them the largest opportunity, as they always have done and as they ought to do.

It is the subject matter that should engage the attention of the agricultural student concerning which we are likely to differ most widely in opinion. Those who are seeking for members of a faculty or station staff are bound to concede that, as a rule, altogether too many graduates are poorly trained for these positions, largely because they are poorly fitted in the sciences fundamental to the line of work in which they offer themselves.

For instance, candidates for positions in horticulture are generally obliged to confess a woeful lack of acquaintance with physiological botany. Those supposed to be specially trained in animal nutrition rarely have the necessary knowledge of organic and biological chemistry, and graduates in agronomy are likely to be more familiar with superficial facts than with soil chemistry and the science of plant nutrition. Judging cattle, corn and fruit; grafting trees, visiting orchards, calculating rations are exercises of small training value, even small vocational value, compared with severe attention to the processes of nature that underlie agricultural practise of all kinds. If many of the colleges expect to give their graduates a good start on the road to success as teachers and station workers they should seriously consider a curriculum that deals more largely with the fundamental sciences and less with agricultural technics as a superstructure.

And should not the same policy be followed with those who are to enter practical agriculture? A fact of fundamental importance in this connection is that the farmer is equipped for success in farm practise not so much through expert handicraft as through a knowledge of conditions that determine the successful growth of plants and animals; in other words, an acquaintance with nature's processes. The mechanical details of agriculture are comparatively simple, but the control of nature's resources is complex and difficult. With great respect for the opinions of those who hold opposite views, I am constrained to express the conviction that the man is best prepared for the life of a farmer who knows the most about the fundamental sciences and their relation to his vocation, and for this reason I can but regard the time as comparatively inefficiently spent that is devoted in college to observations and exercises of an ultra practical character, or to gaining information that is easily acquired from the ordinary experiences of practical life. This doctrine may be reactionary but it is in accordance with move-

ments now in progress in other vocational schools. We have fallen into the error, it is to be feared, of regarding the student mind as a storage tank for useful facts rather than as an instrument to be fashioned into soundness and efficiency. We must never forget that the farmer is comprehended in the man. And when we realize that many of the graduates of these institutions will exert a dominating influence upon the mental and moral development of young men and women, we see a most important reason why their education should not be confined to the narrow line of technical training. And above all, as has been urged, these graduates are to be members of society.

After all, what are the supreme objects of education? It has been reported, though I do not credit the statement, that a member of an agricultural college faculty once declared that the business of his institution was to bring about the production of more hogs at greater profit. If this remark was made, what a spectacle it pictures! It places the hog at the pinnacle of educational aspiration with man as a lesser figure. In sharp contrast to this gross conception of educational ideals stand the sentiments of great minds who have seen broadly and clearly the larger issues of life.

Hill says of education that it should "quicken a man's mental perceptions, form in him the habit of prompt and accurate judgment; lead to delicacy and depth in every right feeling and make him inflexible in his conscientious and steadfast devotion to all his duties." Milton wrote that "the main skill and groundwork of education will be to temper the pupils with such lectures and explanations as will draw them into willing obedience, influenced with the study of learning and the admiration of virtue, stirred up with high hopes of living to be brave men and worthy patriots."

Listen to Mill:

> The moral or religious influence which a university can exercise consists less in any express teaching than in the pervading tone of the place. Whatever it teaches it should teach as penetrated by a sense of duty; it should present all knowledge as chiefly a means of worthiness in life, given for the double purpose of making each of us practically useful to our fellow creatures and of elevating the character of the species itself.

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A STUDY OF RETARDATION IN THE SCHOOLS OF MINNESOTA[1]

The Materials.—The statistics brought together in this paper were gathered, for the most part, in two separate investigations. One, relating principally to retardation, in all its aspects, was conducted under the auspices of the Minnesota Psychological Conference. The other, concerning itself mainly with the first year of retardation, or with repeaters, was made at the request of the Associated School Boards of Minnesota.

Part of the data collected was laid before these bodies at their respective 1910 meetings. Both reports have been combined, condensed, rewritten, and several sets of other interesting statistics introduced for comparative purposes.

The Schools Studied.—The schools contributing the data on retardation proper are fifty-five of the smaller systems of the state. They each maintain high schools, known in Minnesota as "state high schools," owing to the fact that they are carefully inspected and listed with the State High School Board for a large yearly special grant direct from the state treasury. They are, therefore, schools which are kept at a high state of efficiency.

Only Grade Pupils Considered.—Only the pupils in the grades below the high school are considered, for several reasons. First, the high school students are invariably promoted by subjects, hence accurate statistics as to

[1] Presented before Section L, American Association for the Advancement of Science, at the Minneapolis meeting.

retardation among them, in the usual sense of the term, can not be had. Then, again, with the eighth grade once passed, and often earlier, the most retarded pupils, being safely beyond the compelling influence of the truancy law, or of social opinion, quickly drop out of school and the problem of retardation becomes so confused with the problem of elimination as to make the figures of doubtful value.

A State-wide Study.—The schools studied were well distributed over the state so as to embrace every variety of size, location and environing conditions, and to make the study fairly representative of the entire state, and the results are believed to be an index to the prevailing conditions throughout the state.

The Ayres Standard for Retardation.—In the Ayres investigations, published by the Russell Sage Foundation, children in the first grade are considered normal if they are under eight years of age. In the second grade ages under nine are normal, and so on through the grades. The reasons for thus allowing an extra year are not given. The text asserts that these are the ages allotted to the grades "by common consent." But certainly it is not in accord with the actual practise in administering schools in Minnesota, and I doubt if it is anywhere. Its effect is to conceal one year's retardation for every child during his progress through the grades, provided he entered at six years of age, and last year only 441 children in the schools under consideration entered later than six, while very many entered earlier, as they are usually admitted if they are six by the middle of the year.

A child entering the first grade at six should be in the second grade at seven, the third at eight, and so on. Now suppose he fails to "make grade" while in the second grade and remains there two years, repeating and retarded, yet his age, when he enters the third grade would be only nine. By the Ayres method that would be considered normal, and yet he is retarded. By that method it is possible, then, for every child in a school system to be retarded one year after entrance, and yet the system to appear absolutely free from retarded pupils.

The Minnesota Standard for Retardation.—In every school system covered by this investigation the children are admitted at six years of age or younger. We have reckoned the entering age at six. Further, in every one of these schools promotions are made only once a year, in June. Each grade by its very conception means a year's work. Therefore, the child who enters the first grade at six should enter the second at seven, the third at eight, and so on, grade by grade. And further, from the administrative point of view, the state expects to provide the child with only eight years of grade schooling, which is to begin at the age of six. From this point of view the child who waits till he is seven before entering is already behind the schedule. He will get out later and have one year less of economically productive working life, and that is what the state has in view in the education of its children.

The Tabulated Statistics.—The complete results of the investigation are given in Table A. This gives the grade-age status of 17,279 grade children in fifty-five cities and villages of Minnesota. They were gathered in the fall and account for children actually enrolled. This makes the showing favorable to the schools, for some children who failed to win promotion no doubt dropped out during the summer.

Retardation is computed upon the Minnesota basis of entering at six, and spending a single year and no more, in each grade.

TABLE A

Shows, grade by grade, and by sex, the amount of retardation

Grade	Numbers			Percentages					
				Retarded		Normal		Advanced	
	Total	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1	2691	1436	1255	38.7	33.6	63.8	59.0	7.5	7.4
2	2065	1096	969	54.0	41.1	37.8	47.2	8.2	11.7
3	2164	1134	1030	61.1	57.7	33.1	40.9	5.8	7.4
4	2268	1134	1134	65.9	56.1	28.2	35.5	5.9	8.4
5	2129	1109	1020	68.8	63.2	25.2	29.8	6.0	7.0
6	1944	977	967	73.7	67.7	21.0	25.0	5.3	8.0
7	1862	929	933	70.4	65.9	24.3	27.1	5.3	7.0
8	2007	886	1121	74.0	67.0	30.5	26.4	5.8	6.6

Total 17,279 Averages: 58.9 34.2 7.1

In studying this table you will note three things, all, probably, contrary to popular belief. First, the boys equal or exceed the girls in number in every grade up to the seventh, where they fall only four behind. It is in, or at the close of, the seventh grade, then, that the boy meets his decisive defeat. Second, the workings of the process of elimination can be clearly seen in the last three grades. The normally placed child would enter the sixth grade at eleven; the retarded ones would be older. But discouragement, economic pressure in the homes, and the non-applicability or the non-enforcement of the truancy law permits them to drop out. Third, the retardation begins heavily in the very first grade and steadily increases grade by grade through the eighth grade, with the exception of the downward drop of the curve in the seventh grade, due probably to the working of the law of elimination. Also, the retardation of the boys is greater than that of the girls right from the start, and remains so, grade by grade, varying from an excess of 5.1 in the first grade to 7 per cent. in the eighth grade.

The average percentage of retardation officially reported to exist in these schools, under their own standard of requirements is 58.7. As I have said elsewhere when the course of study makes requirements, such that only 41.3 per cent. of the pupils can and do meet them, we have a curious state of affairs resulting, where to be abnormal is the usual or normal state of affairs.

Reduced to the Ayres Standard.—The Ayres method of computing retardation would be incorrect according to the conditions governing the school systems under consideration. But for the sake of comparison, the data on hand have been computed by that method and the results are shown in Table B.

There the average percentage of retardation is 30.9 per cent. And that is serious enough. This, however, is only 52.6 per cent. of that amount known to exist in these schools. The balance is concealed by the allowance of an extra year in the grades, for possible late entrance, when such entrances are so few as to warrant no such allowance.

The Ayres figures for thirty-one important cities give an average of 33.7 per cent. of retarded children, varying from 7.5 in Medford, Mass., to 75.8 per cent. among the colored children of Memphis, Tenn.

TABLE B

This is Table A reduced to the Ayres standard for retardation

Grade	Percentages								
	Numbers			Retarded		Normal		Advanced	
	Total	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1	2691	1436	1255	14.6	9.1	77.9	83.5	7.5	7.4
2	2065	1096	969	22.5	17.3	69.3	71.0	8.2	11.7
3	2164	1134	1030	30.6	20.8	63.6	71.8	5.8	7.4
4	2268	1134	1134	38.2	27.7	55.9	63.9	5.9	8.4
5	2129	1109	1020	44.2	34.8	49.8	58.2	6.0	7.0
6	1944	977	967	47.4	38.5	47.3	53.5	5.3	8.0
7	1862	929	933	44.2	36.3	50.5	56.4	5.3	7.0
8	2007	886	1121	45.3	39.5	49.2	53.9	5.5	6.6
Total	17.279			Aver. 30.9		62.0		7.1	

TABLE C

Some statistics for purposes of comparison

Children in Grades	Minnesota	Ayres
Of fifty-five systems	58.7	30.9
Of forty-one systems (4–5 teachers)	64.6	33.9
Of four special systems	66.5	33.7
Of St. Paul system		56.5
Of Fargo, N. D., system	55.6	24.9

The forty-one schools given in item two are what are termed "graded schools" in Minnesota. They are small but inspected schools ranking below systems having high schools. They are mostly small, with four to five teachers. They enroll 5,340 grade pupils.

The four "special" cities are large systems whose figures are not included with the fifty-five cities given above. They are conceded to be among the best in the state. They enroll 3,753 grade pupils.

There are 2,087 children in the Fargo contingent.

The St. Paul enrollment in round numbers was	23,000
The other 101 cities and villages enroll	28,459
Table C carries this total	51,459

Repeaters.—Possibly one of the best ways to get at the real loss in a school system is to

compute it from the number of repeaters. Here no confusion results over the question of their age at entrance nor the age limits proper for each grade. Elimination works confusion here as well as by the first method tried. And we must bear in mind that repeaters are only one year's contribution to the full army of retarded children. Financially it is only during the time he repeats that the retarded child costs the taxpayer anything.

In order to ascertain at first hand the amount of repeating in the schools of Minnesota, I recently sent out a printed questionnaire to all the superintendents in the state. Ninety-six, which is nearly half, replied promptly with well-arranged data.

The figures given include a total of 40,710 grade children and 8,302 high-school students. To this number we might add about 28,000 pupils in the grade and high schools of St. Paul which are not included in the main results. That makes a total of 77,012 children investigated as to the repeating among them.

The number of children repeating the work of their grade for this year was found to be as follows:

Grades								
1st	2d	3d	4th	5th	6th	7th	8th	Total
664	309	296	374	396	330	318	443	3,130

Also, 168 others are repeating the work for the second time.

And in the high schools 981 are repeating one subject; 335, two subjects; 108, three subjects, and 60 all four subjects. That is equal to a total of 2,214 in single subjects, or, dividing by four, the number of subjects usually carried by a high school student, we have the equivalent of 553 high school students repeating full work.

This is 7.4 per cent. of the total enrollment in the 96 systems. But this does not adequately measure the ground lost last year in these schools, for two reasons. First, the statistics being gathered in the fall from the actual enrollment of the schools and not compiled from office records does not account for the number of students who dropped out during the summer, and the number thus eliminated must be considerable. Second, and this is an important factor, never alluded to, so far as I have discovered, in the literature of the subject, there is a practise, almost uniform among superintendents, of promoting a child at the end of two years in a given grade, whether his work merits it or not. This practise conceals a considerable amount of the very worst sort of repeating, and likewise, by forcing the child on through the grades, whether deserving or not, reduces the apparent amount of retardation. Akin to this practise is another which has the same effects, of promoting "on trial" children who do not quite meet the requirements, but for one reason or another are permitted to continue on with the class. And need it be added that when once a child has been allowed to go on with the class he is rarely reduced to the grade below, no matter how poor his work?

The data show 1,612 children promoted on trial; there are no figures for the number arbitrarily promoted at the end of the second year in the grade. It is certain that these two practises reduce the actual number of repeating and retarded children considerably.

Compared with Ayres's Results.—While my figures show a considerably larger percentage of retarded children, those of Ayres, curiously enough, show in the fifty-five leading cities given in his tabulated report, that the average percentage of repeaters is 15.4. That is due, I think, to the fact that his method conceals part of the retardation but not of the repeating. Repeating is high in the large cities. If repeating is high retardation should be.

Having carefully studied the laggards in our Minnesota schools from two standpoints, it is interesting to note how strikingly the results agree. We found the percentage of retardation to be 58.9 and that of repeaters to be 7.4. Now, bearing in mind that the number of repeaters is merely one year's quota of retarded ones, and multiplying 7.4 by eight, the number of years in the grade course, we have 59.2 as the calculated number of laggards. The ascertained number is only .3 of one per cent. less than this.

The Money Cost of the Laggards.—School administrators and the public generally would

consider the gist of the whole problem to be its fearful money cost. Money spent on doing the same work twice over is money wasted.

Minnesota spends annually for her schools about $15,000,000, and if 7.4 per cent. of this is spent on repeaters then the loss is $1,110,000.

It is estimated that the nation similarly loses from 57 to 80 millions from the same cause.

We justly boast of our great school fund in Minnesota, of about $27,000,000, but here is a sum two or three times as great wasted yearly in the United States because of loss and waste in our management of the public schools along this one line alone.

The True Loss.—The true loss, however, is the spiritual one, which refuses to submit to statistical investigation. The retarded pupils personally lose that fine spirit of initiative, of progress, of growth, of self reliance and of eagerness to achieve, which constitutes the chief glory of youth, and which sends him from school into life an effective member of society. By allowing him to become retarded that birthright of the American boy is traded for the pottage of idleness, failure and self-distrust.

F. E. LURTON

ANOKA, MINN.

AN ANTHROPOLOGICAL SURVEY OF CANADA

A STEP forward in the development of anthropological studies in America was taken September 1, 1910, by the establishment of a division of anthropology under the Geological Survey of Canada. This gives anthropology a government status in Canada similar to that which it enjoys in the United States, where the Bureau of American Ethnology is recognized as the most important body undertaking the study of aboriginal America. The establishment of the Canadian Division of Anthropology was due primarily to the activity of a committee of the British Association for the Advancement of Science, on the Ethnographical Survey of Canada. This committee, of which Rev. Dr. G. Bryce was chairman, was appointed in 1909 at the Winnipeg meeting of the Association[1] and recommended to the Dominion Government the establishment of a systematic anthropological survey of Canada in connection with the opening of the new national museum. The recommendations of this committee were supported by delegations of the Archæological Institute of America and the Royal Society of Canada.[2] Though the actual governmental recognition of anthropological work in Canada is thus to be immediately credited to the efforts of these scientific societies, in a larger sense the anthropological division is the outcome of many years work on the part of Dr. G. M. Dawson, formerly the director of the Geological Survey, and Dr. Franz Boas. These may be said to have started the ball rolling, the former by the work on the natives of British Columbia that he did in connection with his geological surveys, the latter by the more systematic undertaking of ethnologic, physical anthropologic, and linguistic studies in the same part of Canada in the eighties and nineties under the auspices of the British Association. The present affiliation of the division of anthropology with the Geological Survey is in a large measure due to the personality of Dr. Dawson, to whose earlier efforts, at last analysis, is mainly due the recognition by the Canadian government of the importance of anthropological work. The ethnological and archæological collections of the national museum have their nucleus in collections either obtained by Dawson himself or through his efforts. It is interesting in passing to note that the Bureau of American Ethnology at Washington began by affiliation with the United States Geological Survey, the connecting personality in that case being J. W. Powell.

At the present time the anthropological di-

[1] See Report of the 79th Meeting of the British Association for the Advancement of Science (Winnipeg, 1909), London, 1910, p. cxxxviii. See also Professor J. L. Myres's address to Section H, *ibid.*, pp. 616, 617.

[2] See Report of the 80th Meeting of the British Association for the Advancement of Science (Sheffield, 1910), London, 1911, pp. 265, 266.

vision consists of a scientific staff of three—the writer, who was put in charge as ethnologist and anthropologist on the date already given; Mr. C. M. Barbeau, whose appointment as assistant in anthropology began with January 1, 1911; and Mr. Harlan I. Smith, formerly of the American Museum of Natural History, New York, whose appointment as archeologist took place on June 15 of the same year. The appointment of three men to the scientific staff within a year is not to be taken as mere mushroom growth, but primarily as an evidence of the clear insight on the part of the Canadian government into the needs of anthropology; it was understood at the very beginning that the various scientific interests involved in the term anthropology could not well be successfully undertaken by one man. As it is, the services of a physical anthropologist are badly needed, and it is hoped that before a great lapse of time this important branch of anthropological work will also be adequately provided for.

The work being undertaken by the division is naturally confined in the first instance to Canada itself. However, it is clear that to draw a hard and fast line between Canada and Alaska, Greenland, and the United States is in many respects artificial. Owing to the necessity of including Alaska and Greenland in a general study of the Eskimos, it goes without saying that these territories will at least to a certain extent have to be included in the work of the division. In the case of tribes which, like the Ojibwa and Iroquois, are found within the borders of both Canada and the United States, it is clear that the division will be called upon from time to time to pass the boundary. In some cases, as in that of the Ottawas and Wyandots of Oklahoma, what were formerly Canadian tribes have moved far south well within the bounds of the United States; also in these cases "trespassing" is logically necessary.

So much for the geographical limits set. The subject matter of the work undertaken may be conveniently classed under the heads of ethnology, archeology, physical anthropology, for which, as already noted, there is at present no adequate provision, and linguistics. While it is perfectly clear that cultural, physical and linguistic units do not need to, and in numerous instances actually do not, coincide, it should be emphasized that all three classes of units are to a large extent interwoven; not infrequently slim evidence for a point of reconstructed culture-history obtained from the study of one of these may be strengthened and even reduced to certainty by evidence derived from a study of one of the others. It is no mere accident that the Eskimos form a clearly established unit as regards culture, physical type and language. It is thus clear at the outset that any thoroughgoing attempt to attack the problems of aboriginal America must make use of all three units of classification.

To many it will seem that much has already been done in the study of Canadian ethnology. Relatively to other parts of the world that might be named this is true. The results of the Jesup North Pacific expedition have done much to clear up the cultural problems of the West Coast; the culture of the Eskimos in its main outlines and, in certain cases, even in detail can be said to be well ascertained through the researches undertaken, among others, by the Bureau of American Ethnology and the American Museum of Natural History; finally, the Plains and Eastern Woodlands cultures have been studied to a limited degree by Wissler and Hoffman, to mention but two of the ethnologists who have concerned themselves with these areas.[2] Relatively, however, to the standard that must be set for ethnological work both in completeness and thoroughness, the work already accomplished represents but a small fraction of what students of primitive cultures would like to see done. Each of the five culture areas into which it is customary to divide Canada (Eastern Woodlands, Arctic or Eskimo, Plains, Plateau-Mackenzie and West Coast) still present problems of great importance; in

[2] The late Dr. William Jones is known to have obtained a mass of valuable ethnological and linguistic data on the Ojibwa, but his results are as yet inaccessible to students.

some cases it may even be said that the satisfactory proof of the existence of the culture area as a definite unit in contrast to other areas still remains to be proved. This is particularly true of the Eastern Woodlands and Plateau-Mackenzie regions, both of which are perhaps more negatively than positively characterized by contrast to neighboring cultures that have a more definite individuality of their own. It is yet to be demonstrated whether there is really enough of fundamental importance in common to such widely differing tribes as the Nascopie, Iroquois and Ojibwa to warrant their inclusion in a single Eastern Woodlands culture area. This reservation may turn out to be justified also in the case of the Athabascan tribes of the Mackenzie River region as compared with the Kootenay and Salish tribes of the plateau to the west.

Naturally, before these wider problems can be intelligently discussed, more explicit data than are now available must be obtained on such tribes. Outside of the work already referred to of Hoffman on the Ojibwa and Menominee, work moreover which concerns itself with tribes located within the borders of the United States, there is almost nothing published of great merit on the aboriginal cultures of the Eastern Woodlands. Nascopie, Montagnais, Malecite, Micmac, Abenaki, Algonkin, Ottawa, Cree are names frequently enough met with in ethnological literature, yet concerning which, when all is said and done, little enough is known. Even the Iroquois have been neglected to a most astonishing extent. Morgan's Iroquois work, as pioneer work, was invaluable and still commands high respect, yet, as is becoming increasingly evident, needs careful revision. Moreover, the scale on which he worked was much too small to satisfy the requirements of ethnological students to-day. Many problems of interest in the Eastern Woodlands await solution. Some of these are: The extent of influence of the Eskimos, if any, in the lower St. Lawrence region; the extent and characteristics of the birch-bark industry in this culture area; the establishment of the range of the various types of houses used; the clear understanding of the distribution and development of the different types of social organization, from the apparently amorphous bands of the Crees to the complex organization of the Iroquois; the possibly intrusive character of the Iroquois culture itself in this area; the development of a distinctive maritime culture among the Micmacs.

The Eskimo, though, as already noted, already satisfactorily investigated, still present many problems of interest. Several of the less easily accessible tribes are as yet practically unknown. Until these have been investigated it will be difficult to undertake a satisfactory analysis of Eskimo culture as a whole, and, consequently, of its relations to the neighboring cultures.

In the Plains region the Sarcee and Western Cree are as yet hardly more than mere names. The Assiniboine have not yet been exhaustively treated, while Dr. Wissler's study of the Blackfeet, though promising from what he has already published to be eminently satisfactory, will doubtless leave something to be desired owing to the fact that his material was not obtained with the help of linguistic study.[4] Naturally the religious, social and other problems of the Plains region can not be discussed without reference to the Plains tribes of the United States, yet at least two problems peculiar to the Canadian Plains may be pointed out. Both of them are studies of Plains influence exerted on an originally Woodlands tribe. Reference is had to the culture of the Plains Cree and to that of the Saulteaux or Plains Ojibwa.

The Plateau-Mackenzie area is known least satisfactorily of all. Teit's work on the interior Salish tribes of southern British Columbia

[4] It may be said incidentally that all investigation of native mythology, rituals, songs and allied subjects, undertaken without the help of linguistic study, must fail to result in a complete understanding of the native concepts involved. We would not think much, for instance, of a student of the history of the Roman Catholic church that knew no Latin, or of a discussion of German folk songs, even in their purely musical aspect, not based on some familiarity with German itself.

constitutes a model of ethnological research, but the tribes that he describes have been so much influenced by the West Coast and Plains cultures that they are presumably far less typical of the culture area than the Athabascan tribes of the Mackenzie Valley. A thorough investigation of these tribes (Chippewyan, Slaves, Yellow Knives, Dog Ribs, Hare and Loucheux) is probably the greatest single need of ethnological research in Canada. Among these tribes, if anywhere in the dominion, we may expect to find the simplest and most fundamental forms of aboriginal American culture, granted that there is such a thing as a fundamental American culture substratum. The Athabascan tribes to the west, including the various tribes of the interior of Alaska known as Kutchin, are also important in this connection. Similarities in culture which are likely to turn up between the Plateau-Mackenzie and Eastern Woodlands regions (one may instance the similarity in technic between the birch-bark basketry of the east and that in the west of Athabascan and Interior Salish tribes) may be explained as due either to the persistence of fundamental American traits in both regions—we would be here dealing with Dr. Boas's "marginal" theory—or to the secondary spread of such features from one region to the other.

In the West Coast area many cultural problems likewise await investigation. Only of the Kwakiutl can it be said that we have a really exhaustive series of studies, due to Dr. Boas's many years of research, accessible to the student. For the Haida and Tlingit much of fundamental value has been already published, notably by Dr. Swanton, yet here our knowledge is less complete. Of other important tribes of the area (Bella Coola, Bella Bella, Tsimshian, Coast Salish and Nootka) we are relatively uninformed, except in regard to particular points here and there. Further research on these latter tribes will not only serve to give us a more complete picture of the distinctive culture of this region, but may cause us to modify somewhat our idea of certain fundamental elements of the culture. It may be pointed out, for instance, that the Nootka do not illustrate a pure system of paternal descent, for the writer found that all sorts of privileges, even of such purely masculine interest as rights to whaling secrets and rituals, could be inherited through the female as well as male line of descent.

Of scientific work in Canadian archeology there is doubtless even less at the disposal of students than of ethnology. If we except the work of Mr. Harlan I. Smith on the coast and interior of southern British Columbia, and some rather scattering work done by Boyle and others connected with him in Ontario, there is almost nothing to record that is worthy of serious consideration. An archeological survey of Canada must be of the greatest possible assistance to the student of Canadian aboriginal culture in estimating what elements of material culture are truly characteristic of any particular culture area and what on the other hand are due to secondary influence. It is to be expected that many problems touching the movements of population in early times and the centers of the dispersion of cultural elements will receive great aid from archeological methods.

Our knowledge of the native languages of Canada is far from complete, even where considerable masses of grammatical and text material are at our disposal. The quality of the work is not generally all that can be desired. Of Kwakiutl, Tsimshian and Haida we have a reasonably satisfactory knowledge, of the other languages of Canada we are in many cases already informed of the fundamental traits of structure and in some cases, as in that of Ojibwa, we even possess extensive dictionaries, yet a poor phonetical groundwork and a failure to grasp the traits of morphology from a purely objective standpoint vitiate the value of much of this material. Adopting a reasonably high standard of linguistic work, such as one might now adopt in discussing works dealing with Indogermanic or Semitic linguistics, we can safely say that, so far as represented in Canada, none of the Athabas-

can,[5] Salish, Kootenay, Eskimo,[6] Algonkin or Iroquois languages have as yet been adequately dealt with. The time is at hand when purely descriptive linguistic study in America will have to be supplemented by comparative and reconstructive work; it is becoming increasingly evident that such research requires the most minute attention to phonetic detail.

The physical anthropology of aboriginal Canada needs to be put on a sounder and wider basis than heretofore. Outside of Dr. Boas's work on the physical types of the West Coast and interior regions adjoining the coast, practically nothing has been accomplished in Canada with strict regard to scientific method. As a result all present attempts to classify the native physical types of the dominion must be merely approximate.

It can hardly be hoped that the newly established division of anthropology will be able unaided to make the ideally complete survey that has been outlined. The cooperation of other institutions and individuals interested in anthropological problems is not only welcome but necessary. Complaints are sometimes heard as to the duplication of field work among natives. Rightly considered such duplication should always be welcomed, for the personal equation in the investigation of social sciences is a feature which, though often tacitly ignored, must always be reckoned with.

The ethnological work already undertaken by the division embraces three distinct lines of inquiry. The first of these was undertaken by the writer among the Nootka, and resulted in the amassing of much material of linguistic and ethnological interest. It is intended to carry forward this work from year to year. The second line of inquiry is the analysis of the culture of the Iroquois, including under this term the Huron-Wyandots, who were never included in the league. This work was undertaken for the Huron-Wyandots by Mr. Barbeau, who, beginning with the Hurons of Lorette and the few Wyandots still left in western Ontario, took up an intensive study of the most conservative group of Wyandots, those of Oklahoma. The study of the Iroquois proper, particularly from the point of view of social organization, was entrusted to Dr. A. A. Goldenweiser, of Columbia University, who has amassed much of value at Grand River Reserve. The third point of attack was the culture of the eastern Algonkin tribes. Here a beginning was made by Dr. Cyrus MacMillan, of McGill, among the Micmac, and by Mr. W. H. Mechling among the Malecite. It is hoped to begin systematic work among the Cree, Ojibwa, Plains tribes and tribes of the Plateau-Mackenzie region as soon as opportunity will permit. So far the archeological work of the division has been confined to a preliminary reconnaissance, by Mr. Smith, of the field in eastern Canada. Hand in hand with research and publication, which must naturally form the main activity of an anthropological survey of Canada, is the building up of an anthropological section of the national museum at Ottawa. At present the museum is relatively rich in West Coast ethnological and Ontario archeological material to the neglect of other fields. Persistent efforts are now being made to round out the resources of the museum.

The Canadian government is to be congratulated on having established a systematic survey of aboriginal Canada. Now or never is the time in which to collect from the natives what is still available for study. In some cases a tribe has already practically given up its aboriginal culture and what can be obtained is merely that which the older men still remember and care to impart. With the increasing material prosperity and industrial development of Canada the demoralization or civilization of the Indians will be going on at an ever increasing rate. No shortsighted policy of economy should be allowed to interfere with the thorough and rapid prosecution of the anthropological problems of the dominion. What is lost now will never be recovered again.

E. SAPIR
GEOLOGICAL SURVEY OF CANADA

[5] Yet Father Morice's grasp of Carrier phonetics seems excellent.

[6] Except for Kleinschmidt's and Thalbitzer's work on Greenland Eskimo.

THE MUSEUM OF ANTHROPOLOGY OF THE UNIVERSITY OF CALIFORNIA

The Hearst collections in archeology and ethnology of the University of California, were opened for public exhibition on October 4, 1911, in its temporary quarters at the Affiliated Colleges in San Francisco, with a reception tendered by Mrs. Phoebe A. Hearst and the regents of the university to 400 guests.

Mrs. Hearst organized expeditions in California and in Peru, Italy and Egypt in 1899 and 1900, though more or less systematic collecting had been supported by her for some years previous. In 1901 a department of anthropology was organized, of which F. W. Putnam was director from 1903 to 1909. In 1903, owing to lack of suitable building on the campus at Berkeley, the bulk of the collections was removed to the vacant western building at the affiliated colleges, which measures about 75 by 100 feet and includes three stories and a basement. Here the collections were gradually unpacked, ordered, catalogued and put into a condition of accessible storage, which rendered them available for study and for the inspection of limited parties of visitors.

During 1911 Mrs. Hearst provided for placing the greater portion of the collections under glass, to assure their protection and make possible their public exhibition. The museum is now open to visitors daily throughout the year, excepting Mondays, but including all Sundays and holidays, from 10 A.M. to 4 P.M. The exhibits displayed consist of: Ethnology of the California Indians; Archeology of Peru; Archeology of Greece and Italy; Archeology of Egypt, and a revolving exhibit. This last is changed periodically at intervals of about two months, a new unit collection illustrating some definite point in the history of man, or showing some new accession, being installed each time. In addition, exhibits of the ethnology of the Indians of the north Pacific coast, and of the southwest, are in course of preparation.

A part of the Peruvian and Egyptian collections, all the abundant series of specimens illustrating the archeology of California, and the material from the Plains Indians, the Pacific Islanders, the Philippines and other regions, must remain, for the present at least, in storage, awaiting either the permanent building that will ultimately be the home of the collections, or a more extensive equipment than is now available.

Mrs. Hearst's gifts to the museum and the researches carried on in connection with its work have approximated a million dollars, making the largest single contribution to the furtherance of anthropology ever made in America and perhaps in the world. The present value of the collections may be estimated to be several times their original cost. A number of other patrons who have supplemented Mrs. Hearst's efforts have helped to round out the collections and bring them up to a total of 70,000 well coordinated specimens. There are only two other university museums of anthropology in the country that are comparable in scope and importance, and only the great general museums in New York and Chicago, and the National Museum in Washington, surpass the university's museum in size. Both as regards magnitude of the collections, therefore, and the extent of investigations prosecuted, as represented in the publication in American archeology and ethnology, the university occupies a distinctive place among the institutions of the country that have given their attention to anthropology.

SCIENTIFIC NOTES AND NEWS

The Symons gold medal of the Royal Meteorological Society has been awarded to Professor Cleveland Abbe, of the United States Weather Bureau.

Dr. J. M. T. Finney, associate professor of surgery in the Johns Hopkins University, has declined to permit the committee of trustees in charge to present his name for the presidency of Princeton University.

Professor R. DeC. Ward has been elected a corresponding member of the Deutsche Meteorologische Gesellschaft.

PROFESSORS W. H. PERKIN, F.R.S., and E. Rutherford, F.R.S., of the University of Manchester, have been elected corresponding members of the Munich Academy of Sciences.

AT its last meeting the Rumford Committee of the American Academy of Arts and Sciences made the following appropriations: To Professor John Trowbridge in aid of the researches upon thermoelectricity of Mr. Harvey C. Hayes, of Harvard University, $300; to Mr. Frank W. Very, for his research on the intensity of spectrum lines, additional to previous grant, $150; to Professor Robert W. Wood, in aid of his researches on the optical properties of vapors and on long heat waves, additional to previous grant, $225.

THE Australian Antarctic expedition, under the leadership of Dr. Douglas Mawson, sailed from Hobart for the south in the ship *Aurora*, on December 2.

MR. E. A. COCKEFAIR, professor of agriculture in the State Normal School, Cape Girardeau, Mo.; Professor Arthur D. Cromwell, of Humboldt, Ia., and Mr. S. K. White, of Ames, Ia., have accepted positions to do extension work in agriculture for the Agricultural College in Porto Rico.

PROFESSOR J. H. NORTON, who has been in charge of the Citrus Experiment Station, University of California, located at Riverside, Cal., for the past three years, has handed in his resignation to take effect February 1, 1912. Professor Norton will fill the position of horticulturist for the Fantana Development Company, Rialto, Cal.

E. P. CATHCART, M.D., D.Sc., Grieve lecturer in chemical physiology, University of Glasgow, has been appointed research associate of the Carnegie Institution of Washington, and is spending the present academic year in research on metabolism in the Nutrition Laboratory in Boston.

THE Massachusetts Institute of Technology has had for a visiting guest Senor Joao Ferlini, secretary of the College of Engineers, Porto Alegre, Brazil. He has made the tour of the technical institutions of Europe, it being the intention of the government of Brazil to send a number of the best of the students to some foreign institutions to finish their studies.

THE following announcements are made in English journals by the British Meteorological Office: Mr. G. I. Taylor, fellow of Trinity College, Cambridge, Smith's prizeman, 1910, has been appointed Schuster reader in dynamical meteorology for three years from January 1, 1912; Mr. L. Southerns, of Emmanuel College, Cambridge, has been appointed special assistant at Eskdale Observatory; Mr. G. Dobson, research student of Gonville and Caius College, Cambridge, has been appointed graduate assistant for research in atmospheric electricity for one year from October 1, 1911. Dr. Arthur Schuster, F.R.S., has presented to the Eskdale Observatory an instrument, made in St. Petersburg from designs by Prince Boris Galitzin, for the registration of the vertical component of seismic movements. Dr. Schuster had previously presented corresponding instruments for registering the horizontal component, so that all three components are now the subject of continuous registration.

PROFESSOR W. T. PORTER, of the Harvard Medical School, gave the Weir Mitchell lecture at the College of Physicians in Philadelphia, on November 3. His subject was "Surgical Shock."

DR. L. A. BAUER gave an address before the Kononklijke Natuurkundige Vereeninging of Batavia, Java, on October 25, the subject being, "The Non-magnetic Vessel, the *Carnegie*, and Her Work."

AT a meeting of the Columbia Chapter of Sigma Xi on November 28 an illustrated lecture on the electric lighting of New York City was given by Professor J. F. Sever, the president of the chapter.

DR. C. P. STEINMETZ recently delivered two lectures before the engineering students of the University of Illinois. The subjects were "Unexplored Fields in Engineering" and "The Nature of Electrical Energy." The audience at each lecture crowded the lecture-

room of the physics building, in which the lectures were given.

Professor John Perry, F.R.S., delivered the address at the opening of the new mechanical engineering laboratory of the Municipal Technical Institute, Belfast, on November 24.

A life-sized marble statue of Æsculapius, a replica of one in the Vatican, was presented to the College of Physicians, Philadelphia, by Dr. Richard H. Harte, and accepted on behalf of the college, by Dr. S. Weir Mitchell, at the November meeting of the college.

Memorial exercises in honor of John Bascom, a former president of the University of Wisconsin, will be held at the university on December 6. President Charles R. Van Hise, of the university, will preside at the exercises and Dean E. A. Birge, a personal friend of Dr. Bascom, will deliver the principal address. James F. Trottman, of Milwaukee, president of the university board of regents, will speak on behalf of that body, while Judge R. G. Siebecker, of the Wisconsin Supreme Court, will represent the alumni.

A brass tablet has been unveiled by the Master of Peterhouse in the College Chapel, Cambridge, in memory of Dr. Arthur Jackson, who died at Mukden, Manchuria, in January last, in his brave efforts to stem the advance of the plague into China.

Dr. J. F. W. Ross, professor of gynecology in the University of Toronto, died on November 17, from injuries received in a motor-car accident.

Dr. William Sutherland, of Melbourne, known for his contributions to molecular physics, has died at the age of fifty-two years.

Mr. Eugene William Oates, who while engaged in the British India Service and afterwards, published several books on ornithology, died on November 16, aged sixty-six years.

Formal distribution has been made of the California property of the late D. O. Mills. The Metropolitan Museum of Art, New York, receives $100,000, the American Museum of Natural History $100,000, the New York Home for Incurables $100,000, the New York Botanical Garden $50,000, the American Geographical Society $25,000 and the American Red Cross Society $25,000.

The annual dinner of the New York Academy of Sciences and affiliated societies will be held at the Hotel Endicott on December 18, and will be followed by the annual meeting of the academy for the reception of reports and election of officers. The address of the retiring president, Dr. Franz Boas, who is at present on leave of absence from Columbia University to serve as professor of anthropology in the University of Mexico, will be presented. This will be followed by an illustrated address by George Borup, who was one of Admiral Peary's scientific associates on his Polar expedition.

The Edinburgh University Club has been established in New York City and the inaugural dinner will be held at the Astor Hotel on December 27. All graduates and undergraduates of the Edinburgh University are invited to be present. Particulars regarding the club may be obtained from the interim secretary, Dr. W. F. Maloney, 20 E. 69th St., New York City.

The second International Congress of Entomology will be held, as has already been announced, at Oxford on August 5–10, 1912, under the presidency of Professor E. B. Poulton, F.R.S. According to a note in *Nature* the executive committee proposes to find for members of the congress lodgings in the town, or rooms in one or more of the colleges at a moderate charge; rooms in college will be available only for men. The executive committee invites an early provisional notice of intention to join the congress, in order to be able to make the arrangements for the necessary accommodation. The proceedings of the first congress are in the press and will be published shortly. All communications and inquiries should be addressed to the general secretary of the executive committee, Dr. Malcolm Burr, care of the Entomological Society of London, 11 Chandos Street, Cavendish Square, London, W.

THE new student ward in the Madison General Hospital will be ready for patients within a short time and will provide the University of Wisconsin with much needed facilities for caring for sick students. The new ward consists of two adjoining rooms and a heated sun porch, which are located on the first floor of the recently constructed addition to the hospital. Nine students can be accommodated in the ward at one time. The student ward in the city hospital is the result of many years' agitation, both on the part of citizens and students. Seven hundred dollars was raised for the ward by students of the university and Thomas E. Brittingham, of Madison, a regent of the university, gave $5,000 to the hospital on condition that a ward for university students be maintained.

THE government of the Federated Malay States has, as we learn from the London *Times*, offered to make a collection of the fauna of that region for presentation to the Zoological Society of London, and the council of the society has cabled an acceptance of the offer. Mr. Herbert C. Robinson, the director of the States' Museums at Kuala Lampur, has been entrusted with the formation of the collection, and already a number of animals have been obtained. The Zoological Society has agreed to send out a keeper to arrive in Selangor about the middle of March, 1912, to assist in preparing the animals for shipment and to return with them to England. The collection will leave Port Swettenham about the middle or the end of April, so as to avoid the rough monsoon in the Indian Ocean and to arrive in London in early summer. The collection will be exhibited throughout the season of 1912 as that of the Federated Malay States. The more permanent of the enclosures for the king's African collection have been retained, and the Malay animals will be placed in them.

THE first volume of the "Annual Tables of Constants and Numerical Data, Chemical, Physical and Technological," compiled and published by an International Commission appointed by the seventh International Congress of Applied Chemistry (see SCIENCE, August 4, 1911), is now open to subscription. Subscription blanks, the terms of subscription and descriptive leaflets may be obtained from any one of the three American commissioners: Dr. G. N. Lewis, the Massachusetts Institute of Technology, Boston, Mass.; Professor G. F. Hull, Dartmouth College, Hanover, N. H., and Professor J. Stieglitz, the University of Chicago, Chicago, Ill.

WITH the issue for January–March, 1912, *The American Journal of Religious Psychology and Education* will become the *Journal of Religious Psychology, including its Anthropological and Sociological Aspects*, having as editors President G. Stanley Hall and Professor Alexander F. Chamberlain. The journal will continue to be published at Clark University under the auspices of the library.

A MINNESOTA geographical society was recently organized at the University of Minnesota. Professor Edward M. Lehnerts, of the department of geology and geography, was chosen president and Professor F. C. Miller, of the St. Paul Central High School, was chosen secretary-treasurer. Professor Sardeson, of the university, spoke on the opportunities for geographical excursions in and around the Twin Cities. The following were appointed a committee to plan for excursions for the late fall and next spring; Professor Sardeson; Warren Upham, librarian of the state historical society; Professor D. Lange, of St. Paul; Eugene Van Cleff, of the Duluth Normal School; Charles C. Colby, of the Winona Normal, and Jack Haynes, of the Northern Pacific Railway.

AT the first meeting of the year of the Biological Club at the Oregon Agricultural College, Professor Victor L. Gardner gave an address on "Fundamental Factors of Plant Nutrition with Special Reference to the Blueberry." A second address on "The Relation of Plant Pathology to the Other Biological Sciences" was given by H. L. Rees, of the crop pest staff, and H. S. Jackson, professor of botany and plant pathology, spoke on the new additions to the plant pathological library.

THE surgeon general of the army announces that preliminary examinations for the appointment of first lieutenants in the Army Medical Corps will be held on January 15, 1912, at points to be hereafter designated. Full information concerning these examinations can be procured upon application to the "Surgeon General, U. S. Army, Washington, D. C." The essential requirements to securing an invitation are that the applicant shall be a citizen of the United States, shall be between 22 and 30 years of age, a graduate of a medical school legally authorized to confer the degree of doctor of medicine, shall be of good moral character and habits, and shall have had at least one year's hospital training as an interne, after graduation. The examinations will be held concurrently throughout the country at points where boards can be convened. Due consideration will be given to localities from which applications are received, in order to lessen the traveling expenses of applicants as much as possible. The examination in subjects of general education (mathematics, geography, history, general literature and Latin) may be omitted in the case of applicants holding diplomas from reputable literary or scientific colleges, normal schools or high schools, or graduates of medical schools which require an entrance examination satisfactory to the faculty of the Army Medical School. In order to perfect all necessary arrangements for the examination, applications must be complete and in possession of the adjutant general at least three weeks before the date of examination. There are at present sixty-four vacancies in the Medical Corps of the Army.

A SET of 214 enlarged photographs, illustrating plant societies, habit-, flower- and fruit-characters of trees and other higher plants, as well as habit and structural characters of some of the larger algæ and fungi, has been installed in the systematic museum of the New York Botanical Garden. The photographs, which are 11×14 inches in size, are mounted in glazed frames, 43 of them bearing four each of the bromide enlargements and seven bearing six each. The frames are fastened to the walls of the museum on the second floor and, so far as practicable, have been placed near the cases containing representatives of the species illustrated. The enlargements have been made chiefly from 4×5 negatives obtained by various garden expeditions to Florida, the Bahamas, Cuba, Haiti, Santo Domingo, Porto Rico and Panama.

THE Polish National Alliance of the United States of North America has presented to the National Museum an extensive and interesting series of coins of the kingdom of Poland issued during its day of independence. The collection has been placed on exhibition in the west hall of the old building of the National Museum. The series comprises 312 pieces of money, most of which are silver, ranging in size from our old silver three-cent piece to the present-day silver dollar. The series begins as far back as 1386 and covers a period of 449 years.

THE *Harvard University Gazette* records among the activities of the Peabody Museum that during the summer Dr. Alfred M. Tozzer and Mr. Clarence L. Hay made a trip to Mexico. Mr. Hay purchased a valuable collection which he has given to the museum. Dr. Charles Peabody represented the museum at the Prehistoric Congress of France, held at Nimes in August, 1911, and presented a paper on "The Archeology of the Delaware Valley," with special reference to the work of Mr. Ernest Volk. While in Europe Dr. Peabody visited several prehistoric sites, and collected, with the assistance of his European colleagues, representative specimens from the eocene, pseudo-eolithic site of Clermont-de-l'Oise; the eolithic industries of Salinelles (Gard); the industries, neolithic and others, near Orpierre (Hautes Alpes); the Lake Dweller stations of the Saut de la Pucelle and of La Gresine, Lac du Bourget (Savoir). The research in relation to the antiquity of man in America was continued in the Delaware Valley by Mr. Ernest Volk, and a report by Mr. Volk on the twenty-two years of research in this region has been published by the museum. Dr. George P. Howe conducted an expedition to Yucatan and has prepared a report on the

results. Mr. Samuel J. Guernsey carried on archeological researches in New Brunswick for the museum. The museum had a party in Ohio under the direction of Mr. B. W. Merwin, and the long-continued exploration of the ancient cemetery at Madisonville, as well as the famous Turner Group of Mounds in the same region, has been completed.

UNIVERSITY AND EDUCATIONAL NEWS

IT is announced that the sum of $1,526,965 has been collected for McGill University. Included in the sum are three subscriptions of $100,000 each from Dr. James Douglas, of New York, Mr. Robert Reford and the Birks family, of Montreal.

LAST year Mr. John D. Rockefeller offered to give $250,000 to a special endowment fund of the Medical Department of Western Reserve University on condition that a total fund of a million dollars was given. At that time Mr. H. M. Hanna gave $250,000 as part of the required amount. It is now announced that the sum of $429,000 has been given, leaving $71,000 to be collected before December 31.

DARTMOUTH COLLEGE will eventually receive what is believed to be approximately $200,000 by the will of Elijah M. Topliff, of Manchester, N. H.

NEW greenhouses have been erected at the University of Vermont at a cost of $7,000. The buildings consist of a head house 24 × 84 feet, a story and a half high, and three parallel glass houses each 20 × 60 feet. These houses are for the combined use of the department of horticulture, botany and plant pathology: one of the houses is entirely for experimental work, and will be occupied by the experiment station men; the other two houses are for teaching purposes.

THE registration of students in several of the larger universities is reported to be as follows: Columbia, 7,429; Chicago, 6,466; Minnesota, 5,965; Wisconsin, 5,538; Pennsylvania, 5,389; Michigan, 5,381; Cornell, 5,104; Illinois, 5,118; Harvard, 5,028; Nebraska, 4,624; California, 3,450; Missouri, 3,141.

RECENT appointments in St. Louis University School of Medicine are: A. S. Pearse, Ph.D. (Harvard), associate professor of biology, in charge of the department; H. G. Bristow, A.M. (Missouri), instructor in chemistry; A. M. Brown, A.M. (Washington University), assistant in biology; L. F. Shackell, B.S. (St. Louis), instructor in pharmacology.

DR. CHARLES SHEARD has resigned as professor of preventive medicine in the University of Toronto.

M. RANVIER, professor of general anatomy at the Collège de France, has, at his own request, been allowed to retire.

DISCUSSION AND CORRESPONDENCE

THE FRANCIS GALTON LABORATORY FOR NATIONAL EUGENICS

TO THE EDITOR OF SCIENCE: In examining the correspondence of the late Sir Francis Galton I find very many appreciative letters concerning his work from Americans distinguished in science or social activities. Sir Francis held the faith—and did much to demonstrate it—that man both mentally and physically was the product of his ancestry, and that accordingly when this was once fully recognized, man could achieve a greater future by encouraging the multiplication of the fit, and restricting the production of the unfit. He devoted most of the later years of his life to preaching this gospel and left the residue of his fortune to maintain the staff of the laboratory which bears his name. The science of eugenics, defined as "the study of agencies under social control that may improve or impair the racial qualities of future generations either physically or mentally," has been his creation. The idea that we can study at the university what makes for or mars national welfare is not a narrow one, it is essentially international in character. And that view of it is emphasized by Sir Francis Galton's world-wide correspondence. That correspondence leads me to believe that in America, and elsewhere, there may be men and women willing to aid us in founding a worthy memorial

to the life-work of Sir Francis Galton—to his great idea that the future of mankind lies largely in man's own hands, if he will but pay the same attention to his own reproduction that he gives to that of his cattle and his dogs.

The memorial to Sir Francis has taken the fitting form of a building, with public museum, library and lecture hall, with rooms for research students, for experimental work, and for staff—to be called the Galton Laboratory. The sum required is $70,000, of which nearly $12,000 have already been subscribed by Sir Francis's personal and scientific friends in this country. Any one wishing to aid in this memorial to a man, scarcely less noteworthy in science than his cousin Charles Darwin, should communicate with Sir Edward Henry Busk, the treasurer to the Francis Galton Memorial Fund, University of London, England.

Karl Pearson

AN EARLY DISCUSSION OF HEREDITY

I have lately come across a passage which seems worthy of being put on record against the time when the history of opinion and discovery in the science of heredity comes to be written. It is to be found in a work entitled "The Religion of Nature Delineated," by William Wollaston, some time of Sidney Sussex College at Cambridge, a member of the distinguished family which has contributed so largely to scientific knowledge. In Section VIII. of that work, dealing with "Truths Concerning Families and Relations," the author argues that the affection which determines the sense of obligation between relatives is directly dependent upon the intensity of the consanguinity that exists between them. Such consanguinity is regarded as a physical relation which decreases in geometrical proportion with each succeeding generation. The passage would appear to be an adumbration of the views subsequently elaborated by Francis Galton and others. I know of no earlier statement of the quantitative aspect of hereditary phenomena, but should such be known to any of your readers I should be grateful for the reference. The passage transcribed below is taken from a copy of the sixth edition of Wollaston's work which was published in 1738. The book originally appeared in 1722.

The foundation of all *natural relation* is laid in *marriage*. For the *husband* and *wife* having solemnly attached themselves each to other, having the same children, interests, etc., become so intimately related as to be reckoned united, *one flesh*, and in the laws of nations many times *one person*. Certainly they are such with respect to the posterity, who proceed from them jointly. The *children* of this couple are related between themselves by the mediation of the parents. For every one of them being of the *same blood* with their common parents, they are all of the same blood (truly *consanguinei*), the relations, which they respectively bear to their parents, meeting there as in their *center*. This is the *nearest* relation that can be, *next* to those of man and wife, parents and their children, who are *immediately* related by contact or rather continuity of blood, if one may speak so. The relation between the children of these children grows more *remote* and *dilute*, and in time wears out. For at every *remove* the natural tincture or sympathy may be supposed to be weakened; if for no other reason, yet for this. Every *remove* takes off *half* the common blood derived from the grandparents. For let C be the son of A and B, D the son of C, E of D, F of E: and let the *relation* of C to A and B be as 1: then the *relation* of D to A and B will be but $\frac{1}{2}$; because C is but one of the parents of D, and so the *relation* of D to A and B is but the half of that, which C bears to them. By proceeding after the same manner it will be found, that the *relation* of E to A and B is $\frac{1}{4}$ (or half of the half), of F $\frac{1}{8}$: and so on. So that the *relation*, which *descendents* in a direct line have by blood to their grandparents, *decreasing* thus in geometrical proportion, the *relation* between them of *collateral* lines, which passes and is made out through the grandparents, must soon be reduced to an inconsiderable matter.

If then we suppose this *affection* or sympathy, when it is permitted to act regularly and according to nature, no reason intervening to exalt or abate it, to operate with a strength nearly *proportionable* to the quantity or degree of relation, computed as above, we may perhaps nearly discern the *degrees* of that obligation, which persons related lie under, to assist each other, *from this motive*.

R. C. Punnett

NOTE ON THE OHIO PLACODERM DINICHTHYS TERRELLI

In a recent paper[1] Professor Branson describes and figures a specimen of the Devonian "fish" *Dinichthys terrelli*, in the Oberlin collection—a specimen evidently of great value, for it presents for examination many parts, largely in their natural relations, of one and the same individual. Similar specimens, as one recalls (not without chagrin) have earlier been found, and possibly even better ones, but their parts have never been kept together: for the zeal of pioneer collectors led them to separate all possible plates from the matrix, and caused the destruction of smaller undetachable elements, leading, naturally, to a less complete understanding of the anatomy of the "fish." In the present case Dr. Branson has been able to add interesting notes to our knowledge of this classic fossil; he has shown especially that the "clavicular" element of this species is smaller in its proportions than has hitherto been described, and he notes, very justly in this regard, that the restoration of the huge head of *D. terrelli* exhibited in the American Museum of Natural History, "makes the animal much thicker dorsal-ventrally than it should be." His comments, however, are less convincing which concern the actual relations of this plate. We have known that its upper part fitted between the antero-dorso-lateral and the side of the cranium, we have not known, though, just how the plate was placed at the side of and below the suborbital, and the present specimen, in spite of its many virtues, does not appear to clear up this point. Dr. Branson's conclusion that "the inner arm of the clavicular must have come inside the clavicular and prevented the mandible from resting against it" is not quite evident, since it is based upon a "left clavicular (which) lies on the right side, on top of the right clavicular which has lost its lower end." For, unhappily, it is the lower end of this plate which concerns us, and we can not, therefore, feel sure that a plate which has become detached and shifted, will make clear its real relations to the plates near which it happens to lie. We may note in passing that several elements are present in the Oberlin specimen which, as far as we can judge from the picture, appear to have been earlier described, but never relatively in their natural positions; one of these is here shown close to the outer end of the interlateral plate, near a point where another plate should occur, by analogy with *Coccosteus*, but where no element is definitely known.

Bashford Dean

[1] University of Missouri, Bulletin, Vol. 2, No. 2, October, 1911.

THE NUMBER OF STUDENTS TO A TEACHER IN STATE COLLEGES AND UNIVERSITIES

To the Editor of Science: In the table published in your issue of October 27 the University of Minnesota was listed as having one teacher to every twenty-six students. The situation in this institution is by no means what it should be in this regard, but the ratio indicated above is so wide of the mark that I immediately looked up the figures upon which the estimate was based. A copy of the report to the Commissioner of Education is on file here. An examination of the report shows that in the total number of students all the students in the schools of agriculture, which are schools of secondary grade, were included. On the other hand the instructors in these schools were not included in the total of teachers. When this correction is made the ratio is changed from 1 to 26 to 1 to 16. As an average for all departments of the university this is probably approximately correct.

It seems desirable that some system of uniform and comparable statistics should be worked out. For example, there seems to be no definite understanding as to what constitutes a "teacher." Is a man giving himself wholly to research in a laboratory or in an observatory to be reckoned as a teacher? Is a clinical professor who gives part of his time to instruction in a school of medicine to be counted as a whole teacher, or such fraction of a teacher as is determined by the proportion of normal instruction which he offers?

The "students" need to be more carefully defined. Is the unit the individual without

reference to the length of his residence? Is the summer student at Columbia or Chicago, who may be in attendance for six weeks to be reckoned in the total on the same basis with students who are in residence for nine months? Until these things can be determined our statistics will have little value.

George E. Vincent

To the Editor of Science: In your issue of October 27 Mr. Handschin gives statistics from 81 state-supported schools, regarding the number of students to a teacher. These are based on the report of the U. S. Commissioner of Education. I fear that their main use is to illustrate the fact that such statistics often have very little value for purposes of comparing the several institutions.

The University of Wisconsin, for instance, is said to have 7.9 students per teacher, while the University of Michigan is given 15. No one can believe that if these institutions were compared on equal terms one would be found to have nearly twice as many students per teacher as the other. I do not know whether the statistics regarding Michigan are correct, or not, but the figure for Wisconsin conveys a wholly wrong impression. In the number of the Wisconsin faculty, as stated by the U. S. Commissioner of Education, are included the staff of the Agricultural Experiment Station, who do no teaching, and that of the Extension Division, whose students are not included in the catalogue. Thus the real number of students per teacher is greater than that indicated by the report.

The number of "student hours" in the College of Letters and Science has been recently computed. These are ascertained by multiplying the number of students reported in each course of study by the number of credits given for the course. If the sum of these products is divided by 15—the standard number of credits per semester—the result for 1910–11 shows a little over 3,000 "full time students" taught by the faculty of that college. If this number is divided by that of the faculty, the quotient shows 11.1 students per teacher. If the number of assistants in laboratories and elsewhere, who are employed for only partial service, is reduced to that of the full time instructors who would render the same amount of teaching, the number of students for each instructor is 13.3. In the college faculty are included the teachers and executive officers of the college, but not the executive officers of the university nor the staff of the gymnasium, library, etc.

An investigation made by President Van Hise before these statistics were compiled, and covering the whole university, shows about one teacher for 12 students—a result which is not widely different from that stated above for the college.

It is quite probable that if the number of students per teacher were determined in state universities of similar size on a basis which would yield comparable results, the figures would show no such wide differences as are found in Mr. Handschin's list.

E. A. Birge,
Dean

Madison, Wisconsin,
November 1, 1911

Since the tabulations on "The Number of Students to a Teacher in State Colleges and Universities" were published in Science, October 27, some communications have come to the writer complaining of the inaccuracy of the figures. The writer explained that inasmuch as he based his figures on data supplied to the U. S. Bureau of Education by the authorities of the schools themselves, he feels no responsibility in the matter. Evidently some schools have not been over-accurate in reporting their data.

However, this brings up the question of establishing common criteria as to who shall be counted a teacher. This matter has been brought to the attention of the U. S. Commissioner of Education with a petition that he establish some standard which might be incorporated in the blanks which are sent out to receive the data.

Who shall be counted a member of the instructional force? The following suggestions are offered: First, the tabulations should be

made under several heads, as, *e. g.*, professors, associate professors, assistant professors, resident lecturers (librarians and medical directors might be counted here), instructors, and student assistants.

But counting a person a full teacher merely because he teaches the average number of hours, gives no proper estimate of the strength of the school. The salaries paid, if taken in connection with the number of teachers, may well furnish such an index. Thus if six grades of instructors are tabulated as suggested above, and in addition, the sum-total of salaries paid for *instruction* is given, that should suffice to give an equitable rating, as well as to convey explicitly the information desired.

CHARLES HART HANDSCHIN

QUOTATIONS

THE PROPOSED REFORM OF THE CALENDAR

IN the issue of *Nature* for April 27 a concise account was given of the various proposals which have recently been put forward for the reform of the calendar. There is no reason to think that the subject has gained any serious general attention in England, if the fixing of Easter and the dependent festivals be regarded as a distinct question. But it has received a certain recognition in the discussions of some public bodies of an international character, such as the Congress of Chambers of Commerce; and the Swiss government has invited a conference for its formal consideration. In order to bring a definite scheme before the public a Calendar Reform Bill was presented to Parliament by Mr. Robert Pearce. The main features of the bill were briefly described in the article quoted. The first day of the year is called New Year Day, and is placed outside the reckoning of the week and the month. In leap years a day called Leap Day is intercalated between the end of June and the beginning of July, and is equally excluded from the week and the month. By this device there are left 364 days in every year, which are divided into four equal quarters of 91 days. Each quarter is subdivided into three months containing respectively 30, 30 and 31 days. Since 364 is exactly divisible by seven, the first of January always falls on the same day of the week, and the result of making this day Monday is to give 26 weekdays in every month, the four longer months containing five Sundays. Every calendar date corresponds to a particular day of the week (*e. g.*, Christmas Day always falls on a Monday), and the calendar is fixed, no longer changing as at present from year to year.

No doubt such a system possesses slight advantages from the point of view of simplicity over our present calendar. Apart from the objections which must be urged against any disturbance of conventions to which we have grown accustomed on anything less than adequate grounds, the great disadvantage attaches to the scheme that it interrupts the continuity of the weeks. The practical effect of this is seen where two or more calendars are in use side by side. Thus inconvenience must arise even now from the Jewish Sabbath falling on our Saturday. Under the provisions of the Calendar Reform Bill the case would be worse, for it would no longer hold a fixed place in the Christian week.

A second bill has now been presented to Parliament, this time by Sir Henry Dalziel. While differing from Mr. Pearce's bill, the new proposals contain nothing of importance which will be novel to readers of our previous article. For the bill merely embodies the suggestions made by Mr. John C. Robertson at the fourth International Congress of Chambers of Commerce held in London in June, 1910. The differences arise in the treatment of the four quarters of 91 days. These are divided into three months containing respectively 28, 28 and 35 days. Thus each month contains an exact number of weeks, and is made to begin with a Sunday. Incidentally, it is necessary to move Easter Sunday from April 14, as before proposed, to April 15. Also Christmas Day will fall automatically on a Wednesday instead of on a Monday. The advantage of the whole scheme is to obtain commensurability between the month and the week, but it is an advantage dearly bought at the sacrifice of even approximate equality between the

months. This necessitates special legal provision for payments in the case of monthly contracts to be made proportional to the length of the month concerned. Moreover, it requires legal definition for the duration of a "month" from any given date. Thus we understand that a month beginning on any day of the last week of a long month (containing 35 days) will close on the last day of the following month. At least, this is the interpretation which, after careful thought, we have placed upon the following interesting example of parliamentary draughtsmanship:

"8. In calculating monthly periods the following rule shall apply: In any period beginning in a long month and ending in a short month, the last day of the short month shall be held to be the corresponding day to any of the days in the last week of the long month."

If this interpretation be correct, a month may mean any period from 28 to 35 days in length. Surely the clause comes perilously near to a *reductio ad absurdum* to the whole scheme. We can imagine the following simple problem: "A domestic servant is engaged on March 32 at £22 a year. What is the amount of the first monthly payment, and when will it fall due?" We are utterly at a loss to solve the question, and suggest it for the consideration of the framers of the Fixed Calendar Bill.

The fundamental feature common to both the bills alluded to is the use of the *dies non*. Mr. Alexander Philip, who was responsible for reviving the idea of this fiction and advocating its practical convenience, appears to have become impressed with the extent of the opposition likely to be encountered before it can be adopted. Accordingly, in a paper before the section of Economic Science and Statistics, read at the recent meeting of the British Association, and in a pamphlet with which we have been favored, he seems to have abandoned those who are seeking to give legislative form to his ideas, and to advance a totally different suggestion. This requires that February shall gain two days, that July and October shall each lose one day, and that the extra day in leap year shall be placed at the end of June. Then in each quarter (now containing three calendar months) a period of twelve weeks (always beginning on a Sunday) can be found, two such successive periods being separated by a week. The idea is that public engagements can be more conveniently fixed by reference to the proposed twelve-week period, while the correspondence between this reckoning and the ordinary calendar can be very simply exhibited by a "perpetual adjustable" arrangement. But this practically means that we should have two calendars side by side, and no further criticism seems to be necessary.

It is fairly evident that the group of people who are bent on introducing a change in our present calendar are not agreed as to the precise form which that change should take. In the meantime it is probable that public opinion in this country is not ripe for any reform. It would welcome a fixed Easter, but it is more than likely that any radical alteration of the calendar would be resented. Since the reformers adhere to the yearly divisions of the Gregorian system, no scientific question is involved at any point, and the public convenience and public feeling are alone concerned with the issue.—H. C. P. in *Nature*.

SCIENTIFIC BOOKS

Methode der Ethnologie. By F. Graebner. Kulturgeschichtliche Bibliothek, Herausgegeben von W. Foy. Serie I., Ethnologische Bibliothek, Vol. I., Heidelberg, Carl Winter, 1911.

Mr. Graebner is one of the serious and broad-minded students who are not satisfied with an accumulation of facts, but who are carrying through their own investigations according to a well-considered plan, and who try to contribute to science in a certain well-defined line of research and look for results that have a definite bearing upon the whole field of their inquiries. In the present book Mr. Graebner gives us a statement of the method that he is following and which will interest all ethnologists. If, however, Mr. Graebner calls his method *the* method of ethnology, we can not agree with him. He must not expect that all ethnologists will limit the field of their researches in the way set forth

in these "Methods." It appears from Mr. Foy's, the editor's, preface, that in this respect his own views and Graebner's coincide; in fact, in outlining the program of the whole series, Mr. Foy excludes expressly "alle geschichtsphilosophischen und völkerpsychologischen Betrachtungen" (p. v). This exclusion of the psychological field seems to me to give to the whole "Method" a mechanical character, and to be the essential cause of differences of opinion between the author and myself which I shall briefly characterize in the following pages.

The book is divided into three chapters: critique of sources, interpretation of data and combination of data. I do not quite share Mr. Graebner's unfavorable view in regard to the lack of critique of all writers on ethnological subjects, and in regard to the feeling that we are confronted by an appalling lack of all method; a feeling that, according to the author, the historian experiences who takes up the study of ethnology. It is true that much that has been written is based on inadequate evidence, and that particularly the so-called "comparative" ethnologists do not weigh their evidence well. Spencer, Frazer and Westermarck, not to mention others, have been criticized again and again by experts from this point of view. However, the whole modern method of ethnology, at least as developed in the United States, is a continuous struggle for gaining a critical view-point in regard to data collected by earlier authors who did not understand the objects and problems of modern anthropology. We believe that a safe interpretation of the older observed data must be based on careful archeological, ethnological and somatological field work. While I see a perfectly sound tendency in these studies, sounder than Mr. Graebner believes it to be, I still recognize the usefulness of the first chapter in which the author expresses the experiences of the historian in a form interesting and important to the unexperienced ethnologist. On the whole, the training given nowadays to students in universities and museums will impress upon them the safeguards on which the author insists, and which are too often forgotten by the amateur.

Our interest centers in the following two chapters: Interpretation and Combination of Data. The fundamental difference of opinion between the author and myself appears in the chapter on Interpretation. He defines interpretation as the determination of the purpose, meaning and significance of ethnic phenomena (p. 55); but he does not devote a single word to the question, how these are to be discovered. He accepts, without any attempt at a methodical investigation, myths as interpretations of celestial phenomena (pp. 56, 57), as, for instance, the Jona theme as signifying the temporary disappearance of a heavenly body; a conclusion which I for one am not by any means ready to accept. At this place the complete omission of all psychological considerations makes itself keenly felt. The significance of an ethnic phenomenon is not by any means identical with its distribution in space and time, and with its more or less regular associations with other ethnic phenomena. Its historical source may perhaps be determined by geographic-historical considerations, but its gradual development and ethnic significance in a psychological sense, as it occurs in each area, must be studied by means of psychological investigations in which the different interpretations and attitudes of the people themselves toward the phenomenon present the principal material. In the case of mythology, by means of which Mr. Graebner exemplifies his considerations, I should demand first of all an investigation of the question: why, and in how far are tales explanatory or related to ritualistic forms? The very existence of these questions and the possibility of approaching them has been entirely overlooked by the author. On the whole, he seems to assume that the psychological interpretation is self-evident in most cases, but that by migrations and by dissemination combinations may be brought about which may lead to misinterpretations in so far as several groups that were originally distinct may be considered as one by origin (p. 64).

Related to this disregard of the psychological problem is Mr. Graebner's claim, that no objective criteria have been found that can prove relations other than those due to historical connection; that the evolutionary investigation can do no more than answer the question: "How can I best and with the least number of contradictions imagine the course of human development in accordance with my general, fundamental views?" (p. 82). Against this method he claims that transfer has been proved to exist everywhere, while the presence of parallel development can not be proved by objective criteria (p. 107). I think, we must say, that certain types of changes due to internal forces have been observed everywhere, and that, therefore, the question of similar or dissimilar evolution through internal forces does not rest on a more hypothetical basis than changes due to transmission.

Another fundamental difference of opinion between Graebner and myself relates to the phenomenon of "convergence," and here again the conclusions reached by the author seem to me due to a narrow, mechanical definition of the term "convergence." He ascribes this idea to Thilenius and Ehrenreich. I may, perhaps, point out that I have raised the essential point in an essay "The Limitations of the Comparative Method of Anthropology,"[1] and again in my essay "The Mind of Primitive Man."[2] Graebner's first error in regard to this phenomenon is one which he shares with almost all other students of anthropogeography. I quote from p. 94: "Gleichartige Erscheinungen können auch durch Angleichung ursprünglich verschiedener Erscheinungen unter dem Einfluss gleicher Natur- oder Kulturumgebung zustande kommen. Da eine spezifisch gleiche Kulturumgebung ausser durch Kulturverwandtschaft aber ihrerseits nur als durch gleiche Naturumgebung hervorgerufen denkbar ist, bleibt diese allein als primäre Ursache von Konvergenzen übrig." This presupposes an existence of a mankind without any individual differences, or an absolute identity of the psychical conditions that are affected by geographical environment. As soon as the psychic basis is distinct, even the most absolute identity of environment can not be assumed to lead to the same result. It is a curious view that is so often held, that when we speak of the influence of environment upon the human mind, only the environment need be considered. Is not in every problem of interaction the character of each of the interacting phenomena of equal importance? In the particular case here discussed we may say that our whole experience does not exhibit a single case in which two distinct tribal groups are so much alike in their mental characteristics that, when they are subjected to the same modifying causes, these mental differences could be disregarded, and it is an entirely hypothetical and improbable assumption that in earlier periods absolute mental uniformity ever existed in distinct groups.

The idea that in cases of independent origin of the same cultural phenomena identity of environment can give the only satisfactory explanation is deeply rooted in Mr. Graebner's mind, for he repeats, on p. 112: "Gleiche Kulturbedingungen bei selbständiger Entstehung können ihrerseits wieder nur auf die Naturbedingungen zurückgehen."

The phenomenon of convergence is next considered as non-existent for two reasons: a theoretical one and an empirical one. The former is based on the consideration that convergence can occur only under identical cultural conditions, and that, therefore, heterogeneous cultural conditions such as are found in cultures not genetically related, can not possibly lead to the same result. The empirical argument is based on a consideration of conditions found in Europe (pp. 113–114). A consideration of the same data leads me to results diametrically opposed to those observed by Graebner. The very fact that in modern civilization a new idea is frequently discovered independently by several individuals seems to me a proof of parallel lines of thought; and Mr. Graebner's statement that

[1] SCIENCE, N. S., Vol. IV., pp. 901–8, 1896.

[2] *Journal of American Folk-Lore*, Vol. XIV., pp. 1–11, 1901.

the thought of only one man becomes socially active, *i. e.*, is adopted, seems to me to demonstrate just the reverse from what he claims. For an idea expressed at a time that is not ready for it remains barren of results; pronounced at a period when many think on similar, convergent lines, it is fruitful and may revolutionize human thought. May I point out that Graebner's own book may be taken as an example of this tendency? For it expresses the same fundamental idea that is so potent at present in all lines of biological research, that of the permanence of unit characters. An idea may become effective whenever the ethnic conditions are favorable to its adoption and development, no matter what the historical origin of the present general status may have been.

The questions of independent origin and convergence can not be entirely separated, and some of the previous remarks may perhaps rather relate to the probability of independent origin which Graebner practically denies. One aspect of the theory of convergence relates more specifically to the question whether two ethnic groups that are genetically distinct, which are confronted by the same problem, will solve it in a similar manner. The theory of convergence claims that similar ways *may* (not *must*) be found. This would be a truism, if there existed only one way of solving this problem, and convergence is obviously the more probable the fewer the possible solutions of the problem. This, however, is not what we ordinarily understand under convergence. Ethnic phenomena are, on the whole, exceedingly complex, and apparently similar ones may embrace quite distinct complexes of ideas and may be due to distinct causes. To take a definite example: Taboos may be arbitrarily forbidden actions; they may be actions that are not performed because they are not customary, or those that are not performed because associated with religious or other concepts. Thus a trail may be forbidden because the owner does not allow trespassing, or it may have a sacred character, or it may be feared. All ethnic units, separated from their cultural setting, are artificial units, and we always omit in our comparisons certain groups of distinctive characteristics—no matter whether the comparisons are made from the point of view of cultural transmission, or of evolutionary series. Thus, in our case, the forbidden action stands out clearly as a unit, that of the taboo, although its psychological sources are entirely distinct—and this is one of the essential features of convergence. Nobody claims that convergence means an absolute identity of phenomena derived from heterogeneous sources; but we think we have ample proof to show that the most diverse ethnic phenomena, when subject to similar psychical conditions, or when referring to similar activities, will give similar results (not equal results), which we group naturally under the same category when viewed not from a historical standpoint, but from that of psychology, technology or other similar standpoints. The problem of convergence lies in the correct interpretation of the significance of ethnic phenomena that are apparently identical, but in many respects distinct; and also in the tendency of distinct phenomena to become psychologically similar, due to the shifting of some of their concomitant elements—as when the reason for a taboo shifts from the ground of religious avoidance to that of mere custom.

In the foregoing remarks I have tried to show why Mr. Graebner's negative critique of parallelism and convergence does not seem to me conclusive. Just as little convincing appear to me the arguments on which he bases his method of determining cultural relationships. Here, also, the fundamental error seems to me based on the complete disregard of mental phenomena. Mr. Graebner lays down the following methodological principle: Two or more phenomena are comparable, and the one may be used to interpret the other, if it can be shown that they belong, if not to the same local cultural complex, at least to the same cultural group" (p. 64). It seems to me an entirely arbitrary hypothesis to assume *a priori* the homogeneity of similar phenomena belonging to the same cultural group. Mr. Graebner explains his standpoint by the example of the discussion of agricul-

tural rites in Frazer's "Golden Bough," and accepts the discussion on account of the homogeneity of the cultural groups of Europe and western Asia, from which the examples have been taken. This part of Frazer's deductions seems to me just as unmethodical as the others which are based on examples taken from a wider series of cultural groups. The concepts of comparability and homogeneity, as I understand them, have to deal not only with historical relationship, but to a much higher degree with psychological similarity, for only as elements of the mental makeup of society do ideas or actions become potent and determining elements of further development. To give an instance of what I mean: If the aged are killed by one people for economic reasons, by another to insure them a happy future life, then the two customs are not comparable, even if they should have their origin in the same historical sources. Graebner's idea appears clearly in the following statement: "If in different parts of the earth peoples are found that are closely related in their ways of thinking and feeling, evidently the same question arises, that has been treated before in regard to cultural forms, viz., whether these similarities are not based on community of descent or on early cultural contact" (p. 112). Such a view can be maintained only if we disregard the action of inner forces, that may lead two people of like cultural possessions after their separation to entirely distinct conditions. In short it is based on the view of a very limited action of internal forces.

Through the restriction of comparability and interpretation exclusively to the phenomena of transmission and original unity—a definition that I do not find given, but that is everywhere implied—and by the hypothesis, that ethnic phenomena that occur in two areas due to transmission or to original unity will always remain comparable and can be mutually interpreted, the author is necessarily led to his conclusions, which are merely a restatement of his incomplete definitions and of his hypothesis; for, if we call comparable exclusively phenomena that are historically related, naturally then there can be no other kind of comparability, and psychological ethnology does not exist.

Exactly the same criticism must be made against the sense in which the term "causal connection" is used. Here also the psychological connections are intentionally excluded, because the psychological argument, its method and validity, are not congenial to the author; and "causal connection" is simply identified with historical connection. On this basis only can I understand the statement that in literary tradition causal relations are directly given (p. 73). This is not meant to refer to modern historical science, but to the literary sources of Asia and Europe. Is not literary tradition on the whole proof of the misunderstanding of causal relations, rather than the reverse—provided we understand under causal nexus not the simple mechanical aspect of transmission, but the complex social conditions that admit transmission and that bring about internal changes.

A correlate of the assumption that ethnic elements that are genetically related remain always comparable plays a most important part in Mr. Graebner's method of proving cultural relations: "Whenever a phenomenon appears as an inorganic element in its ethnic surroundings, its presence is due to transmission." This might be true if primitive cultures were homogeneous units; which, however, is not the case. The more we learn of primitive culture, the clearer it becomes that not only is the participation of each individual in the culture of his tribe of an individual character, or determined by the social grouping of the tribe, but that also in the same mind the most heterogeneous complexes of habits, thoughts and actions may lie side by side, without ever coming into conflict. The opinion expressed by Mr. Graebner seems to me so little true, that I rather incline toward the reverse opinion. It seems at least plausible, although it has never been proved, that on the whole only such ethnic features are transmitted that in some way conform to the character of some feature of the life of the people that adopt them. The criterion in question seems to me, therefore, not accept-

able, until it can be sustained by observed facts.

This idea is probably related to the author's conception of the transmission of cultural elements in the form of complexes. He says: "A migration of single cultural elements, also of tales, over wide distances, without the spread of other cultural possessions at the same time, may be designated without hesitation as a 'Kulturgeschichtliches Nonsens'" (p. 116). I should like to see the proof of this daring proposition. It is, of course, not the question whether one cultural group owes much or little to another one, but whether cultural elements are necessarily transmitted in groups. To take only a few examples. Is not the gradual introduction of cultivated plants and domesticated animals a case in kind? Does not the irregular distribution of tales show that they are carried from tribe to tribe without relation to other transmissions? It seems to me that the more the problem of cultural contact is studied, the more amazing becomes the independence of far-reaching influences in one respect, from the spread of other cultural possessions. The example of language used by Mr. Graebner (p. 111) presents facts entirely different from those which he imagines. Thus we find phonetic influences without corresponding lexical or morphological influences and *vice versa*. The serious defect of the "Method" is here clearly seen. Instead of operating with the purely mechanical concepts of transmission and conservatism relating to the most ancient types of culture, we must investigate the innumerable cases of transmission that happen under our very eyes and try to understand how transmission is brought about and what are the conditions that favor the grouping of certain new elements of an older culture.

I think I have shown that not only the psychological and evolutionary standpoint contain hypothetical elements that must be subject to a rigid criticism, but that the restriction of all ethnic happenings to mechanical transmission or preservation contains many hypotheses the validity of which is open to most serious doubt. Mr. Graebner has failed in his attempt, because he does not apply the same rigorous standard to his own favorite views, that he applies so successfully to a discussion of the evolutionary theory (pp. 77 et seq.). Here he is at his best, and his criticism of the many hypothetical assumptions contained in all theories of the evolution of culture are well taken and should be read and minded by all students of ethnology. In a few cases, particularly in the discussion of correlated ethnic phenomena, he does not seem to do quite justice to the force of the argument, because he prefers a spacial interpretation of these correlations to a sequential one; but both are certainly equally possible and probable.

It is, however, curious to note that, notwithstanding his uncompromising negative position, the author tacitly re-introduces some of the most fundamental concepts of cultural evolution. Thus he speaks on p. 63 of the "well-known tendency of degeneration and disintegration, according to which myths become legends and fairy-tales, significant institutions formal traits"; and again on p. 152: "Undoubtedly sound points of view are, that the beginnings of every phenomenon must be simple and in a way naturally grow, and that the development must be intelligible by the most simple psychological process." My criticism of these assumptions would be much more far reaching than that of Mr. Graebner.

Thus it seems to me that the methods of Mr. Graebner are subject to the same strictures as those of the other schools, and the "Ferninterpretation," "Kulturkreise" and "Kulturschichten" must be considered as no less hypothetical than the "Stufenbau" of Breysig or the sequences of Lamprecht.

In the development of science it is, however, useful to carry through a hypothesis to its limits and to investigate the ultimate conclusions to which it will lead. From this point of view pages 104–151, in which the principle of conservatism and transmission are strained to the utmost with an absolute disregard of all other possibilities, will be helpful for a gradual clearing of our views. Perhaps even more helpful is the actual application that Mr.

Graebner has made of these principles in his chosen field of Melanesia in its relations to the whole rest of the world.

My own opinions in regard to the value of a single evolutionary series, the importance of very old cultural elements that survive in many parts of the world, and the occurrence of transmission over enormous areas coincide to a great extent with those of Mr. Graebner. I also hold the opinion that the discovery of a really new idea is much more difficult than is generally admitted, and therefore a manifold spontaneous origin quite unlikely. Nevertheless, I can not acknowledge that he has given us *any* safe criterion that would enable us to tell that in any given case transmission can be definitely proved against independent origin, and I am just as skeptical as before reading his book in regard to the advisability of accepting Ratzel's "Ferninterpretation." I rather repeat once more the warning that I have given again and again for twenty years: to be rather overcautious in admitting transmission as the cause of analogies in cases of the sporadic occurrence of similar phenomena, than to operate with the concept of lost links of a chain of cultural intercourse.

That through the exaggerated application of a single principle, when several must be admitted as acting, new viewpoints may be discovered—that much I willingly admit, and I enjoy to follow the daring generalizations to which Mr. Graebner is led. I may, however, be pardoned if I can not accept this as the method of ethnology. I see safe progress essentially in the patient unravelling of the mental processes that may be observed among primitive and civilized peoples, and that express the actual conditions under which cultural forms develop. When we begin to know these, we shall also be able to proceed gradually to the more difficult problems of the cultural relations between isolated areas that exhibit peculiar similarities.

Franz Boas

México, D. F.

Phytogeographic Survey of North America. By John W. Harshberger. Being Vol. XIII. of Engler and Drude's "Die Vegetation der Erde." Leipzig, Wilhelm Engelmann. 8vo. Pp. 790, with 1 map, 18 plates and 32 text figures. 1911. 52 M.

The series of monographs issued by Professors Engler and Drude under the title of "Die Vegetation der Erde" reaches the thirteenth number in the stately volume before us. Among preceding volumes are Radde's "Pflanzenverbreitung in der Kaukasusländer," Drude's "Hercynische Florenbezirk," Diels's "Pflanzenwelt von West-Australien," Engler's "Pflanzenwelt Afrikas," etc., all of which have been received with favor by botanists the world over and this prejudices us in favor of this one from the hand of Professor Harshberger.

Unlike the preceding this volume is given in English, which indeed was quite proper in view of its American authorship, and the additional fact that it will be much more available to ordinary students and readers. And it may be said here that I know of no book on scientific botany which is more likely to be read by non-botanical readers than this one. As one reads it he is constantly impressed with the importance to a great number of men of just such knowledge as is brought out here. One wishes it were possible to give as clear pictures to the intelligent layman as are here given to the systematic botanist.

The plan of the work may be stated as follows:

After an English explanatory preface by the author, and a short German summary by Dr. Drude, the book is divided into four great parts, the first of which (92 pp.) is historical and bibliographical. This is followed by Part Second (of 77 pp.) which is devoted to geographic, climatic and statistical considerations. Part Third takes up (in 175 pp.) the geological evolution of the North American continent and its flora, while Part Four (of 358 pp.), which is the body of the book, takes up the phytogeographic regions, formations and associations. The whole is followed by a voluminous Index of Plants (of 85 pp.) which includes helpful synonyms.

Part Four, which, as has just been said, is the body of the work, includes seven chapters. An analysis of these will be helpful as giving some idea of the logical treatment of the subject. The first chapter deals with Arctic and Sub-arctic zones: the second takes up the Atlantic section of the North Temperate zone, with three subdivisions, viz., the Saint Lawrence-Great Lakes Region; the Atlantic-Gulf Coastal Region, and the Piedmont-Appalachian-Ozark Plateau-Mountain Region. Chapter III. is devoted to the Xerophytic Section of the Interior in the North Temperate Zone, with its three subdivisions—the Prairie Region, Rocky Mountain Region and Great Basin Region. The fourth chapter relates to the Pacific Section of the North Temperate Zone, including the Sitka Region, Columbian Region and Californian Region. The fifth chapter takes up the Mexican Subtropical Zone and Mountain Regions. The sixth and seventh chapters are devoted to the North American Tropic Zone, the former to the Mexican and Central American Sections and the latter to the West Indian Section.

The author's purpose which he kept before him as he wrote this book is well expressed in a paragraph of his preface. "But with the settlement of the continent and the exploitation of its resources, such as the drainage of its swamps, the removal of the original forests, and the construction of irrigation works in arid districts, the original condition of the land surface and its vegetation will be changed forever. It is important, therefore, for this generation of botanists and scientists to leave in printed form, in photographs, in maps and in other illustrations a record of the original appearance of the country before the march of civilization has destroyed primitive conditions. This from the standpoint of the botanist is an important matter, because all future botanic and forestry work must be based on considerations of what was the character of the native growth."

With this object in view the author set himself about the task of writing a book which should give the reader a clear picture of the essential features of the original vegetation of North America. It would be quite impossible to give many details in a work covering so large and varied a field, and this the author has not attempted. So when the reader finds his own particular region treated, as he thinks, somewhat too scantily he must remember that this is necessarily the case, and that if the successive pictures contained too much of detail they would lose much in distinctness and sharpness of outline. As one runs over the paragraphs they appear like pen pictures, whose bold outlines leave a series of vivid impressions on the reader's mind, and this is what the author hoped to accomplish. The author has tried to make such a record as would enable future botanists to know what was the character of the original vegetation of North America.

That the book contains errors of fact, and errors of interpretation probably no one will be more ready to acknowledge than its author, for it could scarcely be otherwise with so large a field as the whole of North America, and a department of botany so new as that of ecological phytogeography. The unpleasant task of pointing out the individual errors I willingly leave for others to accomplish. There is so much in the book that is above criticism that one may well settle down to the enjoyment of its reading, as one enjoys a great landscape painting, with the certainty that the general effect is well worth getting, even though some of the hills are too high and too sharp in the painting, and the names and distribution of some of the plants are given erroneously in the book. The great outlines are true, nevertheless.

It remains for me to speak of the fine plates, which are reproductions from well-selected photographs, and the text figures, many of which are similar but smaller "half tones" of photographs. The map of North America showing phytogeographic areas will prove to be most helpful. Nor must reference be omitted to the interesting history of floristic work in the different geographic areas of North America, where the student will find the names of most of the botanists who have had to do with the exploration of the country.

The bibliography, while necessarily only partial, will be very helpful to the student of North American phytogeography.

Charles E. Bessey
The University of Nebraska

TICK (IXODOIDEA) GENERIC NAMES TO BE INCLUDED IN THE "OFFICIAL LIST OF ZOOLOGICAL NAMES"

1. The international committee invited by the secretary of the International Commission on Zoological Nomenclature to make a detailed study of the nomenclature of ticks (Ixodoidea) and consisting of the following specialists in this group, W. Dönitz (Berlin), Albert Hassall (Washington), L. G. Neumann (Toulouse), G. H. F. Nuttall (Cambridge) and Cecil Warburton (London), has submitted its first report.

2. Said committee unanimously agrees that the following eight generic names are the correct names for the genera in question, and that the correct genotypes, according to the International Rules of Zoological Nomenclature, are the species cited:

Amblyomma Koch, 1844*a*, 223–231, type *cajennense* Fabricius, 1787.

Argas Latreille, 1796*a*, 178, type *reflexus* Fabricius, 1794.

Dermacentor Koch, 1844*a*, 235–237, type *reticulatus* Fabricius, 1794.

Hæmaphysalis Koch, 1844*a*, 237, type *concinna* Koch.

Hyalomma Koch, 1844*a*, 220–223, type *ægyptium* Linnæus.

Ixodes Latreille, 1796*a*, 179, type *ricinus* Linnæus.

Rhipicentor Nuttall & Warburton, 1908, 398, type *bicornis* Nuttall & Warburton.

Rhipicephalus Koch, 1844*a*, 238, 239, type *sanguineus* Latreille.

3. Notice is hereby given that the undersigned will wait until July 1, 1912, for any zoologist to raise any objection to any part of the report of the special committee. If no valid point is raised by the date mentioned, the undersigned will transmit the list to the International Commission with the motion that these names be incorporated in the "Official List of Zoological Names," provided for by the last International Zoological Congress.

All correspondence on this subject should be directed to

C. W. Stiles,
Secretary International Commission on Zoological Nomenclature
Hygienic Laboratory,
Washington, D. C.,
October 30, 1911

THE NATIONAL ACADEMY OF SCIENCES

At the meeting of the National Academy of Sciences held in the Public Library, New York City, on November 21 and 22, the program of scientific papers was as follows:

Flexner, Simon: Mode of Infection in Infantile Paralysis.

Loeb, Jacques: Oxidations in the Cell.

Carrel, Alexis (Introduced by Simon Flexner): Manifest and Non-manifest Life of the Tissues.

Conklin, E. G.: Cell-size and Nuclear-size.

Harrison, R. G. (Introduced by E. B. Wilson): Protoplasmic Movement in Embryonic Cells.

Kükenthal, Willy (Introduced by E. L. Mark): The Biological Significance of the so-called Hairs of the Hairy Frog, *Astylosternus robustus* (Blgr.).

Morgan, T. H.: Sex-limited Inheritance.

Davenport, C. B. (Introduced by T. H. Morgan): Recent Advances in the Study of Eugenics.

Osborn, Henry F.: The Problem of Continuity or Discontinuity in the Origin of Unit Characters in Heredity.

Hrdlička, Aleš (Introduced by W. H. Holmes): Ancient Man in South America in the Light of Recent Researches.

Trelease, Wm.: The Leafy Mistletoes of North America.

Grabau, A. W. (Introduced by J. F. Kemp): A Comparison of the Basal Paleozoic in Northwestern Europe and Eastern North America.

Kemp, J. F.: New Data on the Bed-rock Channel of the Hudson River.

Kemp, J. F.: The Source of the Saratoga Mineral Springs.

Smith, Alexander (Introduced by Charles F. Chandler): Recent Experiments on the Effect of the Absence of Moisture upon the Chemical Dissociation of Calomel and other Salts.

Boltwood, B. B.: Proposed International Radium Standard.

Pupin, M. I.: Conductors Rotating in Alternating Magnetic Field.

Osborne, T. B., and Mendel, Lafayette B. (Introduced by T. B. Osborne): The Rôle of Different Proteins in Nutrition and Growth.

Peirce, C. S.: A Method of Computation.

Peirce, C. S.: The Reasons of Reasoning, or Grounds of Inferring.

Walcott, Charles D.: Biographical Memoir of Samuel Pierpont Langley.

Becker, George F.: The Remainders of Certain Mechanical Quadratures.

Wells, H. L.: A Color-effect in Isomorphous Crystallization.

SCIENCE

FRIDAY, DECEMBER 15, 1911

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

PRINCIPLES OF WATER-POWER DEVELOPMENT[1]

1. The development of water-power involves artificial regulation of streams. Proper regulation of running water for the several uses of water supply, irrigation, power and navigation can be effected only in the light of the physical relations, the relations in equity, and the more salient legal relations of water in streams.

PHYSICAL RELATIONS

2. The fresh water of the land is derived directly from rainfall (including snow) and indirectly through evaporation from the sea. The mean annual rainfall on mainland United States ranges from less than 5 to over 100 inches, averaging 30 inches; the quantity aggregates about 5,000,000,000 acre-feet.[2] The distribution is unequal; over the eastward two fifths of the country the mean is about 48 inches, over the median fifth some 30 inches, and over the westward two fifths about 12 inches.[3]

3. In humid lands the water of rains and melting snows tends to gather into streams, generally taking the shortest and easiest paths to the sea, while in arid lands

[1] Presented at a hearing of the National Waterways Commission, November 21, 1911.

[2] The acre-foot is a convenient unit not only because in common use throughout arid America, but because large enough to measure water in its national aspect without use of incomprehensibly large figures. It equals 43,560 cubic feet, 326,047 gallons, or 1,359.6 tons; it is something over a kilostere (equaling 1.2335 ks.), or cube of 10 meters.

[3] "Soil Erosion," Bureau of Soils Bulletin 71, 1911, p. 17.

(except in a few rivers fed by the greater rain and snow of mountains) it tends to spread into débris-laden sheetfloods and will not flow down to the sea; lakes, in which water lodges for a time, are essentially expansions of streams due to what may be called geologic accidents—*e. g.*, the Great Lakes chiefly to glacial scouring, the Millelacs to the irregular configuration of glacial-drift surfaces, Great Salt and Winnemucca Lakes originally to warping of the earth-crust; waterfalls, in which power is easily developed, are also due to geologic accidents—*e. g.*, Niagara and Genesee and St. Anthony to conditions attending withdrawal of the Pleistocene glaciers, the cataracts of the Susquehanna and Potomac and James and the Dalles of the Columbia to displacement in the earth-crust.

4. In humid regions (including mountains in which rain and snow are more abundant than over neighboring lowlands) the streams carry a part only of the water reaching the surface—*i. e.*, the run-off, averaging about one third of the rainfall; about half the aggregate is evaporated, partly from the soil and open waters though more freely from growing vegetation, forming the fly-off; while a smaller fraction (the cut-off) passes deeply into the earth to be absorbed in chemical combination or carried subterraneously to the sea. In arid regions there is (normally) no run-off, and all the water except the small cut-off is evaporated to temper the local climate.

5. In a state of nature—and also under intensive cultivation—little if any storm water flows over the land surface apart from the streams; the rainfall is absorbed by the soil and its vegetal growth, and the streams are supplied partly by springs but much more largely by seepage directly into their channels—this being the normal condition, in which streams are generally clear and nearly uniform in flow.

6. Under certain conditions attending settlement, especially with injudicious clearing and negligent cultivation, a considerable part of the rain falling during storms runs off the land surface, erodes the soil, renders streams turbid, gathers into destructive floods, and introduces wide fluctuations in flow (this representing what may be deemed a temporary condition in the history of the country, and one remediable by proper classification and use of the lands for purposes to which they are adapted, and by intensive cultivation of areas devoted to the growing of seasonal crops).

7. All parts of each stream are interrelated; increase or decrease in volume, inwash of detritus, the initiation of fluctuation, or other changes in regimen at any point eventually affect the stream throughout; especially susceptible to disturbance at the sources are clarity and steadiness of flow at points whence water supply is commonly taken, in the middle course where power development is customary, and in the lower course devoted to navigation.

8. Normal streams, being derived chiefly from seepage, are maintained directly by the store of water accumulated in the ground as the residuum of rains of preceding seasons and decades, and only indirectly by the current rainfall. In the humid part of this country the ground water within the first hundred feet from the surface has been estimated at some 25 per cent. of the volume of subsoil and rock, equivalent to 6 or 7 years' rainfall—*i. e.*, it may be conceived as a reservoir of water 25 feet deep coinciding in area with the humid region. This reservoir is the chief source of the streams available for water-power and other purposes; it is also the reserve agricultural capital of the country,

and the measure of productivity and habitability.

9. Under extensive clearing and cultivation, the store of ground water has been materially depleted. Recent determinations based on records (covering a mean period of about 22 years) of 9,507 wells in the nine states of Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Ohio, Tennessee and Wisconsin reveal lowering of the water-table at a minimum mean rate of 1.315 feet,[4] or with moderate allowance for new wells 1.73 feet, per decade, corresponding to an aggregate of 13.8 feet for the 80 years since settlement began. This lowering of the level of saturation corresponds with an actual loss of water averaging 5.2 inches per decade, or nearly 150,000,000 acre-feet annually within the nine states. The loss is due largely to increased run-off in freshets and floods, which are in increasing degree wreaking destruction of property and loss of life; while innumerable springs and smaller source streams have disappeared, and the regimen of nearly all streams has been impaired.

10. The rate of subsidence of the water-table varies from state to state; in those enumerated it declines from 2.464 feet per decade in Minnesota to 0.8 foot in Ohio, while in Missouri it is but 0.43 foot. When the variable rates are coordinated with the geographic relations of the several states, it becomes clear that the ground-water reservoir of the entire interior is continuous, that Missouri is supplied in part by underflow from the Plains and Rocky Mountains, that the level in Ohio is kept up in part by seepage from Lake Erie (explaining that discrepancy between inflow and discharge from the lake which has led to excessive estimates of evaporation), and that Minnesota has merely lost proportionately with the absence of external sources of supply—in short that throughout this area of 532,402 square miles (and presumably elsewhere in the humid country) the reserve store of ground water is not only continuous and fairly conformable to the land surface but moves slowly down-slope in directions generally corresponding with those of the surface streams.

11. The recent researches demonstrate that the surface streams of the humid coun-

[4] The records are summarized in the table following; the detail figures appear in the Yearbook of the Department of Agriculture for 1911 under the title "Subsoil Water of Central United States."

State	Dates		Total No.	Wells Mean Depth	Bi-state Wells			Mean Lowering	Water-tables		Mean Lowering per Decade
	No.	Mean			Tota	Unchanged	Changed		Total No.	Mean Depth	
Illinois	940	1884	1,224	51.7	925	426	499	2.80	1,224	25.6	1.077
Indiana	720	1887	939	53.5	657	291	366	2.89	939	26.7	1.256
Iowa	1,303	1887	1,527	84.4	1,160	632	528	3.61	1,502	46.1	1.570
Kentucky	579	1887	805	41.2	595	254	341	1.97	805	29.4	0.856
Michigan (lower)	843	1890	987	60.7	720	455	265	2.01	966	33.4	1.005
Michigan (upper)	72	1898	87	42.7	74	26	48	2.29	87	27.2	1.908
Minnesota	1,013	1896	1,158	76.5	920	404	516	3.45	1,132	42.8	2.464
Ohio	956	1880	1,243	44.9	908	425	483	2.41	1,243	24.8	0.800
Tennessee	518	1891	758	54.3	487	235	252	1.94	758	39.0	1.023
Wisconsin	672	1891	779	74.5	620	234	386	3.87	777	49.5	2.037
Aggregate	7,616		9,507		7,066	3,382	3,684		9,433		
Average		1888.3		61.3				2.85		35.1	1.315
Missouri	1,147	1888	1,527	58.7	1,048	710	338	0.95	1,520	33.6	0.432
Grand aggregate	8,763		11,034		8,114	4,092	4,022		10,953		

try available for water supply and navigation no less than power are interrelated through the ground-water reservoir in such wise that the regimen of each is dependent on the integrity of the ground reserve by which it is chiefly maintained. The essence of a stream resides in its continuity of flow; and this continuity of flow is in nature due absolutely and wholly to continuous supply from the store of ground-water.

12. Since the water vapor which bathes the continent and tempers its climate is not all precipitated on the land over which it passes, but in part goes on over adjacent seas; since the part precipitated as rain and snow and distilled as dew is largely reevaporated from soil and open water, especially from growing plants whose vitality it sustains; since the residuum mainly soaks into the earth (and should do so wholly, in order to retain the best natural and artificial balance) where it forms a reserve store of ground water for a period averaging perhaps ten years; and since streams are fed chiefly—under the best conditions wholly—from this groundwater reserve, it follows that the fresh water of the country, as a whole, in its forms of vapor, rain, snow, dew, groundwater, lake and stream, is essentially a grand physical unit made up of interdependent parts, and that each stream, despite its essential unity and the interrelation of all its parts, is but an integer within the larger unit.

RELATIONS IN EQUITY

13. Water is the prime necessary of life. Fully five sixths of human food, and indeed a like proportion of the human body, consists of H_2O or water, chiefly in its simple form, partly in chemical combinations. In the human organism water is essential to assimilation, to metabolism or structural growth, to reproduction—indeed it would appear that no vital process occurs in the absence of water or otherwise than as a manifestation of its inherent properties. In the plants and lower animals yielding human food and clothing, water plays an equally essential rôle—indeed without water the continent would be unproductive and uninhabitable, and the lands of the planet but a dead world.

14. In this as in other countries, water is the primary natural resource. Industrial and other forms of activity on which rest the power and growth of peoples and states depend absolutely on the maintenance of human life and population, which in turn depend on food and measurably on apparel; and whatever its breadth in land and wealth in minerals, no continent can sustain human life and population without sufficient water for drink and for producing from the soil the materials for solid food and clothing. The average crop plant transpires 450 times the weight of its own (dry) substance in water during its growth; and reckoning evaporation from the soil of the moisture required to maintain proper texture, the agricultural duty of water is to produce one thousandth of its weight in average plant crop, or one four-thousandth in grain, or perhaps one forty-thousandth in meat.[5] Under rigid economy an adult human worker may be sustained for a year by 200 pounds each of bread and meat, with 2,000 pounds of water for drink; or, since the bread and meat require for their production respectively 400 tons and 4,000 tons of water, something over 4,400 tons of water in direct sustentation, apart from that required for ablution and for melioration of climate through aqueous vapor in the air.

[5] "'The Agricultural Duty of Water,'' U. S. Department of Agriculture Yearbook for 1910, pp. 169–176.

Under irrigation, where alone agricultural water is measured, a five-acre farm supplied with 60 inches of water per year will sustain a family of five, including surplus produce for exchange; this is at the rate of five acre-feet (about 6,800 tons) per inhabitant—at which rate mainland United States might sustain permanently, with its 5,000,000,000 acre-feet of rainfall, a population of 1,000,000,000; the 2,000,000,000 acres of land would indeed support over 2,000,000,000 people if occupied to the density of Belgium (649 per square mile)—but neither land nor any other resource except water affords any measure whatever of the capacity of the country for production, population, power, or perpetuity.[6]

15. As the primary resource, water alone gives value not only to land (as is clearly realized in arid regions) but to all other resources. It is the ultimate basis of values, and can not equitably be regarded as an appurtenance to land or to any other subordinate resource, though in equity land and other resources may be—and in arid countries are commonly—considered practically appurtenant to the natural water.

16. As the prime necessary of life—the ultimate basis of existence for each of the individuals united in the nation—the water of the country is, under that leading principle of our national existence that all men are equally entitled to life, liberty and the pursuit of happiness, the common and indivisible possession of all—a possession in equity inalienable and indefeasible, since no constituent of the nation could alienate or divest himself of his share without surrendering his right to life and so weakening the nation.

17. As the common property and equitable possession of all, water in any form, together with the appurtenant lands or other resources, may be administered in the public interest by municipalities, states and the national government; but no public agency may in equity alienate, or divest the people of any part of the common interest in the water, nor may it equitably transfer any right to use of the water without just consideration in the public behalf. As the prime necessary of life and the primary resource, and as the common possession of all, water is in itself a special property, and its equitable administration is rightly the most sacred trust confided by the people in their chosen representatives and officers.

18. While the uses of water are diverse, they are not equally essential to life and to that general development of the country on which its power and perpetuity must rest. Since life can exist without it for but a few days, the primary use of water is for drink and other domestic supply, in which it is consumed; since continuous life can be sustained and the generations maintained only through food and clothing produced by its consumption, the secondary use is for agriculture, including irrigation; since the measure of industrial proficiency is the conquest and use of power, the next use of water in order of importance is for mechanical power, in which its substance (or corpus) is not consumed though its movement is utilized; and since the activities of commerce are necessarily subordinate to the primary industries, the least essential use of water is for navigation, in which it is not consumed and only its inert corpus is utilized. Yet the several uses may and should be combined, as when water for domestic supply or irrigation is used for power—and the development of power generally promotes navigation.

19. Since individuals are merged in various business and civic organizations

[6] "Prospective Population of the United States," Science, Vol. 34, 1911, pp. 428–435.

without loss or impairment of their individuality or their rights and duties as constituents of the nation; since the circulation of rain-yielding vapor is wholly independent of civil boundaries, while the movement of ground-water generally, and the courses of streams largely, are independent of such bounds; since water in artificial conduits and hydro-electric power are essentially commodities and the physical means of carrying them are frequently interstate; and since the chief uses of streams commonly vary in different parts of their courses and often in civil divisions, while the federal government alone can deal with interstate navigation and international waters, no municipality or state or federal agency can claim exclusive jurisdiction over water, or the exclusive right to administer it.

20. Since the chief purpose of statutes and common-law and courts is to prevent inequity, so that their nature is static and their effect generally prohibitive or restrictive or at most permissive, while the activity on which development depends is dynamic and constructive and in its essence progressive (wherefore it is not initiated but merely guided in direction by the static qualities of law and court), it follows that the inherently progressive development in the use of water attending the natural growth and orderly development of the people can best be fostered by combining individual and institutional agency in the highest practicable degree—*i. e.*, by effective cooperation among individuals and both business and civic organizations, including corporations, communities, municipalities, states and federal agencies.

LEGAL RELATIONS

21. Most legal relations affecting the uses of the water of the country are prohibitive or restrictive, or otherwise negative in character; comparatively few thus far developed are positive and constructive.[7]

22. Constructive development of the legal relations of water in eastern United States began with Chief Justice Marshall's interpretations of the commerce clause of the Constitution, largely in McCullough *v.* Maryland (4 Wheaton, 316–437) and more specifically in Gibbons *v.* Ogden (9 Wheaton, 1–240), which established federal authority over navigable streams and navigation; and the next noteworthy constructive step was taken by Chief Justice Taney when he cut loose from the English definition of navigability, showed that English standards are wholly inapplicable to this country, and established the principle that the question of navigability is

[7] Normal development of appreciation and equitable use of water in this country was unfortunately retarded through decisions and sometimes through statutes and state constitutions applying (without shadow of constitutional warrant) principles arising in the English common law, under which water is virtually held a mere appurtenance to land—a usage arising in a small and well-watered but nearly riverless island, and not only illogical in itself (in the impossible condition that a user may remove water from a stream provided he does not impair the flow), but wholly inapplicable to a great continent containing large rivers, though insufficiently watered as a whole. Better standards would doubtless have arisen through importation of the French-Roman law (through the Code Napoleon), under which the water may be said to pertain to the community, save that it was practically limited to the over-watered state of Louisiana; and still better standards were actually introduced into the arid region in the Spanish-Roman law, under which water is allotted by prior claim and continued beneficial use and the land is virtually appurtenant thereto, though this equitable principle has been gradually outweighed by the force of the non-equitable English common law brought in from more populous sections.

one of fact (the Genesee Chief *v.* Fitzhugh, 12 Howard, 443, *et seq.*, especially 456–7)—a principle ever since recognized in this country, save as laxity in federal administration and zeal in state aggrandization have permitted insidious invasion of navigable and necessary source streams by devices for other uses of the water. The third step in the same line (with which advance practically terminates) was marked by the Supreme Court decision in the Rio Grande case establishing the power of the federal government to protect the source streams on which depend the navigability of the lower waters (United States *v.* Rio Grande Dam and Irrigation Company, 174 U. S., 690–710)—the oft-quoted Kansas-Colorado case, though conformable, being virtually a nonsuit and of little bearing on principles affecting the general relations of water.

23. The most significant advance in the development of legal relations affecting the primary use of water in this country was made in a decision of the New Jersey Court of Errors and Appeals, subsequently affirmed by the U. S. Supreme Court, that the people of the state collectively have a residuary right in the intrastate waters (Hudson Water Company *v.* McCarter, 209 U. S., 349–358), a manifestly valid doctrine which requires nothing but application in other states with respect to their intrastate waters, and extension to the concomitant federal authority over interstate waters in their nature as navigable streams or as sources of such streams, to work a great public benefit. A development of the same equitable principle appears in an opinion of the Supreme Court of Maine that the legislature may prescribe such control of private property in woodlands as may be required to protect public interests in the permanent water supply conserved by the forests; while the Oregon water law of 1909 by clear implication and the California water law of 1911 in specific terms declare that the waters of the state belong to the people of the state.[8]

24. During recent years the Congress has enacted various constructive laws conformable with and even extending the principles so established by the United States and state courts. The most conspicuous of these is that providing for the reclamation of arid districts by expending certain proceeds of public land sales in diverting water from its natural channels to irrigate dry tracts, thereby promoting the public welfare (conformably with the "General Welfare" clause of the Constitution) through a virtual extension of the public domain in substantial accord with the principle of the Spanish-Roman law under which other resources are essentially appurtenant to water. A related principle was applied in the creation and maintenance, through administrative and legislative action, of national forests designed not only to protect timber but to conserve the water of source streams; and it was definitely established as a national policy within a year by an act providing for the purchase of lands in the Appalachian and White Mountains for the specific purpose of conserving source waters, primarily and ostensibly to protect navigation in the lower rivers—though it was well understood in the deliberations attending the enactment that incidental effects of even greater public benefit would arise

[8] Some state constitutions, as in Colorado, provide that waters within the state belong to the state, thereby setting up a claim to interstate waters bound to eventuate in expensive and fruitless litigation unless the claims are composed by equitable cooperation and sharing of natural and legal rights and duties between the states and the federal government.

from protection of the streams in their middle courses where they may be used for power development without impairment—indeed with promotion[9]—of navigability below, and from the general conservation of the natural water for all other uses (in fact it would appear that this act was passed in direct response to a popular demand based on manifest equities and recognition of the public good rather than on any narrow construction of common-law or statutes or decisions).

25. Sundry enactments by the congress during recent decades serve to establish what may be considered an inchoate national policy touching the development of water-power on navigable streams whereby, (1) when a franchise is given a private corporation to erect dams the federal government reserves the right to use without charge so much of the power developed as may be required for specific purposes, a reservation which may be deemed in the nature of consideration (and recently this was extended by making the consideration specific and limiting the term of the franchise); (2) when works are constructed cooperatively between the federal government and prospective power users the government reserves rights of administration and for specific uses, and also limits the tenure of the lease or franchise to a specified period; and (3) when the dam is constructed at federal cost the leasing of power developed thereby is authorized under conventional restrictions as to advertising, etc.[10] The policy so initiated is not only naturally susceptible of extension with growing knowledge concerning

[9] Not only does each open reservoir for power development hold back the flow of the stream and so shorten the low-water season, but each serves to saturate the adjacent soil and subsoil and rock with an additional volume of water subserving the same end—a volume often comparable with that of the pond itself.

[10] The first case is covered by the provision of the general "Act to regulate the construction of dams across navigable waters" (1906) to the effect that "The person owning such dam . . . shall grant to the United States a free use of water-power for building and operating" any constructions which may at any time be required "in the interest of navigation" (U. S. Stat. at L., Vol. 34, p. 386); and this provision is reaffirmed in special laws of various dates. The second case is exemplified by "An Act to enable the Secretary of War to permit the erection of a lock and dam in aid of navigation in the Tennessee River near Chattanooga, Tennessee, and for other purposes" (U. S. Stat. at L., Vol. 33, p. 309), in which it is provided in Section 4 "That in consideration of the construction of said lock and dam, free of cost to the United States . . . the United States hereby grants . . . such rights as it possesses to use the water-power produced by said dam, and to convert the same into electric power or otherwise utilize it for a period of ninety-nine years: *Provided*, that it or they [the grantees] shall furnish the necessary electric current while its or their power plant is in operation to move the gates and operate the locks and to light the United States buildings and grounds, free of cost to the United States: *And provided further*, . . . That the Secretary of War is hereby authorized to prescribe regulations to govern the use of the said water-power and the operations of the plant and force employed in connection therewith." The third case is covered in the provision of the River and Harbor Act approved June 13, 1902 (U. S. Stat. at L., Vol. 32, p. 358), under the item for "Improving Cumberland River, Tennessee, above Nashville," as follows: "And the Secretary of War is hereby authorized, in his discretion, to grant leases or licenses to the highest responsible bidder for the use of the water-power created by said dam, at such rate and on such conditions and for such periods of time as may seem to him expedient . . .: *Provided*, that any lease or license so granted shall be limited to the use of the surplus water not required for navigation . . .: *Provided further*, that before leasing or licensing such water privileges, or issuing permits for the construction and operation of such canals, or otherwise disposing of any water-power or privilege, the Secretary of War shall first advertise the same in one or more daily papers at Nashville, for sixty days immediately preceding, stating specifically the right or

physical relations and the increasing value of power attending the natural growth and orderly development of population and industries, but clearly requires such extension in the interest of general welfare.

26. Federal legislation touching river and harbor improvements has commonly been kept well within the principles laid down by Marshall and Taney, has apparently disregarded the vital principle established in the Rio Grande case, and has shown little progress in the development of standards and ideals conformably to the needs of a great and growing country either for improved transportation or for better use of streams; yet a notable advance has arisen in connection with the work of the Mississippi River Commission which, in cooperation with state officials in Mississippi, Louisiana, and perhaps other states, has extended its work from merely perfunctory revetment of banks for improving navigability in the lower Mississippi to design and location of revetments in coordination with the state work for protecting adjacent lowlands, and has even aided in levee construction—thereby establishing (1) the principle of cooperation between state and federal agencies, and (2) a recognized duty on the part of the federal government so to control regimen in navigable streams as to protect adjacent lands.

privileges proposed to be leased or conveyed, with its exact limitations, inviting bids for the same, and he may, in his discretion, then lease the same for a specific term of years at so much per year, to be paid semi-annually in cash into the Treasury, and the Secretary of War shall reserve the right to reject any or all bids.'' The extension in the first case is covered in the amended general dam act approved June 23, 1910, by the provisos ''That . . . the Chief of Engineers and the Secretary of War shall consider the bearing of said structure upon a comprehensive plan for the improvement of the waterway over which it is to be constructed with a view to the promotion of its navigable quality and for the full development of water-power; and . . . shall provide for improving and developing navigation, and fix such charge or charges for the privilege granted as may be sufficient to restore conditions with respect to navigability as existing at the time such privilege be granted''; and ''That the authority granted under or in pursuance of the provisions of this Act shall terminate at the end of a period not to exceed fifty years from the date of the original approval of the project.''

27. Repeated enactments by the federal congress in conformity with the work and reports of the administrative departments seem to have established at least in inchoate form a duty of the federal government to take measures looking to the control of all the waters of the country in the public interest: In the War Department the physics and hydraulics of the Mississippi were investigated with a view to control of the river; in the War Department and later in the Department of Agriculture rainfall was measured with reference to drainage basins and stream floods, while of late floods are gaged and flood warnings are issued for the public benefit; in the Interior Department the hydrographic branch of the Geological Survey is gaging all the streams of the country and determining their regimen (including the amount of sediment in the water) with a view to more complete control, the work being sometimes done in cooperation with states; in the same department the operations of the Reclamation Service in diverting streams for irrigation, generally in cooperation with individuals and states, are carried forward vigorously; in several bureaus of the Department of Agriculture investigations and measurements of water are conducted with respect to irrigation, drainage, soil-plant circulation, destructive erosion, etc.—indeed it may be said that the function of the department in dealing

with water and its derivatives—all looking toward increasingly complete control and utilization for the public benefit, while largely in cooperation with individuals and state institutions, the growing knowledge is applied and the control extended from year to year in increasing degree; in the Department of Commerce and Labor the bureau of corporations has made a systematic investigation of navigation with a view to better regulation of both natural and artificial facilities; and in the same department the census bureau has reckoned the actual control of water for irrigation. Under the federal legislation and administrative operations, water is not only measured more accurately than in any other country but is steadily passing under control in the public interest, largely through cooperation with individuals and states, yet always in such wise as to exemplify and establish the common interest of all the people in the water of the country. The advance in this direction during the last decade has been especially rapid; and though apparently little noted, it is among the most significant in our entire history with respect to knowledge, use and administration of the natural waters.

28. Especially in connection with municipalities, a usage has arisen with growing necessities which is congruous with current legal practise in detail, although incongruous with the foreign legal notion that water is a mere appurtenance to land: in all leading cities adequate water supply is provided substantially at public cost, and such lands as may be required to accommodate mains and reservoirs or other works are acquired for the purpose by condemnation or otherwise, while in many cities the lands required for catchment areas are either condemned or purchased, or else arbitrarily protected from contamination—all in accord with the principle of the greatest good to the greatest number; in some cities (notably Los Angeles) the income from power developed by the head of the water is, or is to be, applied in liquidating the cost of both waterworks and land; some municipalities (again notably Los Angeles) allot the surplus water to irrigation for the common benefit, while in many towns and cities the surplus is used in sewerage systems sometimes designed to repay costs through useful disposition of the sewage. The several cases mark growing recognition of the fundamental fact that water is the prime necessary of life and the primary resource, and serve to establish, at least in inchoate form, the doctrine that as population grows dense in relation to the quantity of water, land necessarily becomes a mere appurtenance to that resource on which the lives of the people depend.

29. Under the generally progressive development of legal relations throughout our history, a foundation has been established not only in equity but in law for constructive action by state and federal legislatures, and for judicial decisions more in accord with current knowledge and existing conditions than with archaic standards developed in other countries of different conditions.

30. The essential principle of natural equity on which specific legislation may rest has already found expression, both by statesmen and by powerful associations of citizens including both jurists and publicists, in the incontrovertible proposition —now become axiomatic—that *all the water belongs to all the people.*

PROPOSED APPLICATION OF PRINCIPLES

31. Any action looking toward better utilization and development of the water of the country must be influenced by the

magnitude of the values involved. Since water is the sole source of productivity and habitability, it is the primary basis of all values; and since the property of the country may be appraised at a figure approaching $150,000,000,000, while the water reserve (stored chiefly in the ground) may be estimated at ten years' rainfall or 50,000,000,000 acre-feet, the one may be balanced against the other as the gold reserve is balanced against the currency whose circulation maintains property values. Reckoned in this way the value of the water reserve may be put at $150,000,000,000 in gross, *i. e.*, $3 per acre-foot or 2.2 mills per ton—a reasonable figure, corresponding fairly with the current cost of irrigation water, and far less than any current water rates in cities or even the ordinary margin of rates above the cost of waterworks. In connection with the gross valuation, it may be noted (chiefly on the basis of estimates by the National Conservation Commission toward the end of 1908) that more than 10,000,000 of our people are supplied—largely from protected catchment areas of over 1,000,000 acres—by waterworks, which for 42 cities (not including Chicago, Philadelphia, Cleveland, Cincinnati, *et al.*) cost no less than $271,159,483 and perhaps as much more for catchment basins, and supply 1,324,300 acre-feet of domestic water,[11] worth in round figures computed at $3 per acre-foot $4,000,000 annually; that some $200,000,000 are invested in irrigation works, using 34,000,000 acre-feet of water annually to render productive 13,000,000 acres of arid lands; that the water-power available at a cost comparable with that of steam installation is 37,500,000 horsepower (enough to "operate every mill, drive every spindle, propel every train and boat, and light every city, town and village in the country"[12]), worth in gross earning power $20 per horsepower-year or $750,000,000 annually; that the annual loss through draining away of the ground water in only nine interior states, reckoned at $3 per acre-foot, is $442,000,000; that the estimated yearly loss through soil erosion is $500,000,000; that if navigation were so developed that one fifth of our freight moved by water the annual saving to producers and consumers would be $250,000,000; and that needed drainage of our 75,000,000 acres of swamp and overflow land would add over $20 per acre above the cost of draining (or $1,500,000,000), to our national wealth and provide home-sites for 5,000,000 to 7,500,000 families. Even the most conservative figures indicate that the development, control and utilization of water raises the largest and one of the most pressing economic issues now before the American people.

32. Since the uses of water are interdependent and most of the physical relations interstate, complete control may not be exercised justly either by any single state sovereignty or by exclusive federal sovereignty; so that concurrent legislative and administrative action is required by states and the municipalities within them and by the federal government.

33. Since under the Constitution the federal government is primarily responsible for the general welfare, requisite action may properly, and in view of the urgent demand should without needless delay, be initiated by the congress.

34. The magnitude and complexity of the interests affected, the delicacy of the legal relations involved, and the dearth of both exact knowledge and practical experience concerning the several uses of

[11] Report of the National Conservation Commission (60th Congress, 2d Session, Senate Document 676), 1909, Vol. II., p. 178.

[12] *Ibid.*, Vol. I., p. 41.

water, all indicate that action taken at this juncture should be constructive and developmental rather than definitive. While the relations in equity seem clear, and while the legal relations appear to form a firm foundation for a broader legal structure than has hitherto been attempted, the technical experience needed to guide definitive legislation remains inadequate: it is barely over a decade since electric power transmission began reconstructing industries, since the internal-combustion engine began closing the age of steam (which may reopen under the steam-turbine), since steel-concrete construction began revolutionizing the use of resources, since irrigation began opening a new era in standards of production; and the concepts of even the most advanced jurists and law-makers can hardly be quite abreast with, much less far in advance of, the technical experience attending these industrial developments. Moreover, the concept of water as a common possession in equity of all the people remains novel in many minds, and is bound to result in new and unforseeable interrelations among individuals and civic organizations, and especially between states and the federal government—interrelations that can be adjusted and regulated in the common welfare only as common experience grows with advancing applications of increasing knowledge. It would no more be practicable to establish definitive regulations for the use of the natural waters to-day than it would have been to create our magnificent railway system by fiat 80 years ago, to establish our intricate banking system when the Constitution was framed, or to found by a stroke of the pen 20 years ago the Department of Agriculture with its hundreds of scientific experts, made such by long-continued training. The need for action presses; but wise action to-day can be no more than preparatory for, and directive of, prospective and inevitable development.

35. In view of the interstate relations of our natural waters, action by the congress should be framed with special reference to that comity with and among the states best maintained by sharing, rather than by disputing as of old, common interests—a course in which useful experience has been gained in the Mississippi River Commission and Reclamation Service, as also in the Forest Service and other leading bureaus of the Department of Agriculture; and the federal legislation should not merely form a model for states, but should authorize necessary administrative action directly and in conjunction with states.

36. Since practical experience is a *sine qua non* for wise legislation, early state and federal enactments should be framed in general terms, entrusting the actual work to administrative agencies under proper restrictions and provisions for reporting progress to the legislative authority, much as in the statutory authority for state and federal departments.

37. While the magnitude and importance of the issue involved in control and utilization of water would warrant the creation of a federal department to meet it, such action at this juncture might be premature—especially since the more pressing requirements may be met through existing departmental facilities. The several considerations point toward a presumptively temporary federal administrative agency, created or empowered to make investigations and take action looking toward the progressive control and regulation of the water of the country with respect to all uses, both directly and in cooperation with states and when needful with individuals,

corporations, communities and municipalities—such agency to report through the executive annually and at such other times and in such modes as the congress may require. It should be among the first duties of the federal agency to confer with officers or other competent representatives of states concerning water-power and other uses of water with a view to determining means of effective cooperation, equitable sharing of rights and responsibilities, estimates of cost of works required for state and federal use, reasonable rates for domestic and irrigation water supply and for power, and all other matters of common concern to the state and federal governments—the determinations to be reported to the state legislatures and to the congress as a basis for further action in the public interest in accordance with the righteous principles of the greatest good to the greatest number for the longest time.

38. While it is not necessary and might be inexpedient for current federal legislation to specifically declare the principle that all the water of the country belongs to all the people of the country, the enactments may not equitably, nor judiciously in view of the trend of that public sentiment in which lies the power of the nation, be open to construction as dissenting from or denying that principle; for already this has become part of the body of ethical conviction underlying American character and constituting its strength.

W J McGEE

UNIVERSITY EXTENSION AND THE STATE UNIVERSITY[1]

THE state university is a public service corporation. It is supported by the public presumably *for* the public. Until within comparatively recent years, few questions have been asked as to the quality and comprehensiveness of the service offered by the university to this constituency, but the time has arrived when not only educators, but intelligent laymen, including both employer and employed, are asking to what degree the relation of the people as a whole to the educational system has been recognized.

What proportion of the young folk who become high school students are served in future years by the university? What proportion of those who remain in school for elementary training only, reap more than the most meager benefits from our so-called popular education?

The high average percentage of illiteracy in the United States, the low comparative degree of efficiency in the industries and the avidity with which opportunities for further training are embraced by persons who have completed their formal education, all point to a fault in the existing system, for which there is at present no generally adopted remedy.

It is not my purpose to dwell upon the shortcomings of our public education, nor to enlarge upon the fact that statistics relating to school attendance would give less cause for discouragement if we recognized in our public schools the value of training for efficiency. A radical change in the curriculum, aimed at retaining the interest of the pupil by showing him the value of his education as a usable asset, would tend to lengthen the term of school life for both boys and girls and, in many cases, would prolong it into and through the university.

In view of this lack of what may be called vocational applications in school training, it is not difficult to understand the reason for the almost overwhelming demand from persons engaged in business pursuits for an opportunity to enter, how-

[1] Presented before Section L, American Association for the Advancement of Science, at the Minneapolis meeting.

ever late in life, upon serviceable courses of study.

It is a question upon which opinions differ, whether or not the university is the source from which extension teaching in its present development should emanate, but so long as there is no other agency prepared to do the work, the question admits of an affirmative answer only.

There is much to be said in favor of a policy which associates with the university the work of extending educational advantages to the people in their homes and places of employment. A measure presenting such immense possibilities of usefulness to the whole people, would seem to belong as an organic part to the state educational work. In order to secure permanence of establishment and growth, extension teaching must be given assured and liberal support, and for reasons of economy and convenience its central offices should be placed where the resources of the great head of the state system would be available for its use. The value of this association has been demonstrated in the success of agricultural extension, which could not have flourished apart from the agricultural college, whose instructional force, facilities for research and material equipment have been essential to its usefulness.

Although close affiliation with the residence work of the university is important, this does not imply that extension instruction shall be limited to courses of study of university grade, nor even that it shall conform necessarily to any conventional schedule of studies. The range of extension activities includes not only such courses as entitle the student to credit toward university or advanced degree, school teacher's diploma or other certified recognition, but also short courses and conferences not leading to a degree, and the promotion of a great variety of interests that reach the people, both young and old, in the intimate relations of their daily life.

In this breadth of scope is seen the vital spirit that animates the new conception of university extension—the spirit of boundless liberality, which would make useful to the entire people, in whatever place, in whatever walk of life, that great fund of knowledge which accumulates and is available at a university, be it the product of research, scholarship or of great gifts of mind and heart.

Having conceded the point that the state university is the natural and proper guardian of the educational interests of the whole people of the state, existing under an obligation to those who can not enter her walls similar to that she owes to her resident student body, we are confronted by the paramount question of method by which every part of the state shall be reached by the university without duplication of machinery, yet effectively and thoroughly. In order to solve this problem of covering the field without waste of effort, it is probable that no method can be absolutely successful which does not involve division of the state into districts having local headquarters, from each of which the various activities of extension shall be promoted within the limits of its territory. The organization may then be compared to a great wheel of which the hub is the university, the rim the boundaries of the state, and the spokes the lines which divide the whole into districts. At the hub, or central headquarters, will be located the dean or director, the several secretaries of departments and the specialists who offer lecture courses, prepare correspondence-study lessons, publish bulletins designed to aid the student in the study of topics for debate, or gather, classify and hold ready for the applicant, instructive literature on a wide range of subjects useful to the stu-

dent as a private individual or as a citizen of state or municipality.

At the district headquarters will be placed a superintendent, field organizers and local teachers. The working plant will include, in addition to offices for administrative purposes, class rooms, laboratories and library facilities, conveniently situated for the use of groups of students.

The problem of finding a staff of extension workers possessing the very special qualifications required of them is a serious one, but extension teaching is itself assisting in the preparation of suitable men and women to carry on its work, and furthermore, with the introduction of new methods, extension has ceased to depend solely upon a staff of lecturers who must combine the qualities of public speaker, scholar and philanthropist. An organization similar to that outlined in the foregoing pages, so differentiates and distributes the work that there is no longer the necessity, as in the older forms of university extension, to find men who unite in their individual persons a large number of qualifications. Nevertheless, it must be recognized that certain qualities in the extension worker are of essential importance. The district representative, for instance, must be selected with the most painstaking care, and must combine the tastes and training of a social worker with business acumen, and acceptable personality. His training should have been sufficiently liberal to enable him to understand conditions in his community as they are affected by business relations. If the leading industry of his district is agricultural, he should possess some knowledge of agricultural interests; if manufacturing, he should be more or less of an engineer; if commercial, he should be acquainted with commercial processes. He is the representative for his district of all the specialists of the university, and the knowledge required of him is such as will enable him to place at the service of the people with whom he is related the resources of the state educational center.

Thus far, little has been said of the actual processes of instruction to be carried on by means of the machinery so fully described. Correspondence-study, debating and informal discussion, lecture, information and welfare service may be included in its scope.

It will not be possible in the short time that should be consumed by this paper to enter fully into description or even enumeration of the activities through which the university may serve individuals or communities in all parts of the state.

Detailed description of correspondence-study teaching may be omitted. Its processes are well known and for many years were discredited. At present, it is coming to be accepted as a valuable educational method. In conjunction with weekly or bi-weekly classes, in which the student is brought into personal touch with the instructor, it serves usefully in teaching the industrial employee, whose conditions of life and training as a rule are not favorable to close or unassisted application. While with the trained student, experience goes to prove that correspondence-study may present decided advantages. The testimony of several teachers in The University of Wisconsin, where skepticism prevailed a few years ago, may be of general interest in this connection.

From the head of the department of German in the university:

> We have given correspondence courses in almost all branches of the work of the German department—in grammar, reading, composition, literature, philology and methods of teaching—and these courses when pursued by students of adequate general preparation and maturity have regularly yielded very valuable results in the imparting of both training and knowledge.

I entirely share the opinion of Professor Prokosch, who has carefully watched the results of the work, that former correspondence students entering our university classes have proved that they had derived a full measure of benefit from their work. I may add, however, that I believe such satisfactory results are only where, as at the university, in our case, there is close and harmonious cooperation between the general management of the correspondence work, the instructor actually doing the work, and the regular University department in which the work falls.

From an associate professor of history:

The lesson papers of almost all of my pupils have been of good quality, evincing painstaking and thoroughgoing study and power in the subject. The results of the final examinations have been uniformly good. The three correspondence subjects in which I have had most pupils have been Greek history, medieval history and English history.

At the same time that I have been conducting this history study by correspondence, I have been having quiz sections in these same subjects with pupils in attendance at the university. It is natural that I compare the performance of these two sets of pupils. The requirement made of correspondence pupils was as great as of the residence pupils. The text-books were the same, and the ground covered in each subject was the same for each set. The results obtained from the best of the pupils in correspondence work were fully as good as those from the best in residence work, and the average quality of the correspondence work was superior to the average quality of the work done in residence. This last fact is doubtless due to this, that in a large degree these pupils are a naturally selected group. It is well enough recognized that the thirst for knowledge is by no means the only motive that induces a student to enter college, or to continue there. It is, however, the principal motive that prompts the correspondence pupil to undertake the work and this makes and keeps him very responsive to the teacher's efforts.

A correspondence instructor in Latin says:

I have discovered that the students do more work in these Latin courses than they do in the same work as resident students, a fact that the head of the Latin department in the university has found out recently quite apart from my own discovery.

An instructor in the English department, who also has experience in both university and correspondence work, says:

The student in correspondence work has far more individual teaching than is possible in classroom work, and he comes into closer touch with his instructor, who knows his environment, his ambition and his special needs, and is therefore interested to teach him—not only as a student in general, but as an individual in particular. It is a fair statement that I am in closer touch with each of my correspondence students than I could be with one tenth of them in residence, and I have had many pleasant letters expressing delight that this condition really exists.

You may remember that I rather regretted giving up my teaching to work in the extension division, because I believed so firmly in the value of individual instruction. One of the pleasant surprises in my correspondence work has been the opportunity to continue to do individual teaching.

Unquestionably, the correspondence student loses that intangible something we hear so much about, which university life gives and which many value highly. On the other hand, his work receives closer supervision than that of the resident student and his relations with his teacher, as shown by the letters quoted, are more intimate, though of a different character. The student who takes work by correspondence is usually mature. In residence, he would belong to that class of university student which does not identify itself with many of the ordinary student activities. Consequently, he does not lose so much by doing his work away from the university, and it should not be forgotten that those who take part of their work by correspondence are usually persons who, were it not for this opportunity, would never enter the university at all.

Correspondence study, for purposes of university extension, must include courses of practically every grade. The teaching force must be selected with special reference to the peculiar relations between

teacher and student. The residence instructor is frequently not well adapted to this work. I fully agree, however, with the head of the German department, whose views I have quoted, that the work for credit must be under the careful supervision of the residence departments, since they are responsible to the university for the maintenance of a standard. The work of applicants for degrees, non-resident or resident, must, of course, conform equally to this standard.

Department supervision is, in general, not necessary for the vocational courses, and is not as a rule desirable. There is danger that the influence of the old academic spirit may operate to make vocational correspondence study as applied to industrial workers ineffective and practically valueless. Professional men, including lawyers, physicians, clergymen, teachers and the like, will, naturally, select courses of study that are closely related to the resident work. But a different treatment is required for students of the industrial class who, though mature in years, are immature in mental processes. Many of these have no fixed habits of study, or are unaccustomed to confinement out of working hours, and frequently realize only imperfectly the benefits to be derived from a course of study applied to their vocation. They are often burdened by home cares. The fact that the fee, however small, would help to lighten the home burdens will often affect their judgment, and the present is more significant to them than the future. These students need constant encouragement with close personal contact. They must be shown in the class room, in the shop, or the local laboratory the application of their instruction to the industry in which they are employed. An occasional meeting in the class room under the direction of an instructor, where notes and experiences in the work can be compared, acts as a helpful stimulus.

The method of instruction which combines correspondence study with class work, applied under the conditions of such district organization as has been described, has been successfully applied. In mining districts classes of industrial workers engage under local direction in courses of study designed to improve their proficiency in mining engineering; in manufacturing districts, shop mathematics, machine construction and other subjects fundamental to mechanical processes are studied; in commercial centers, business courses; in rural districts, agricultural subjects; in fact, university extension effectively administered through district organization should offer vocational training in every part of the state directly applicable to the prevalent conditions.

An interesting and valuable phase of extension work has to do with choice of occupation. The Vocational Bureau in Massachusetts has demonstrated that a large field of usefulness is open to the instrumentality that has for its object guidance of the individual, whether young or old, toward the selection of an occupation adapted to his abilities and tastes. Many a man is a failure because he is in the wrong place. The bootblack who is shown the way to fit himself for more remunerative and agreeable work, the clerk who is helped to achieve the broader usefulness for which he has ambition and capacity, in a word, every misfit who is assisted to discover and develop his peculiar abilities becomes a more valuable unit to himself and his community. It is evident that district organization may be a useful agent in bringing the needed opportunity to persons whose latent possibilities are worthy of recognition and development.

Other activities of the district force will

include the introduction of lecture courses; the organization of debating or other clubs; the formation of night classes; the spread of library facilities; the opening of laboratories; the promotion of educational measures in business organizations; the assistance of town or rural communities in civic or social improvement; the conduct of institutes or conferences—the number of these activities is too great for enumeration. The district representative's acquaintance with the people and the organizations in his district, having for their object industrial, social or civic betterment, will enable him to place the university at their service.

An important possibility for extension activity is that which would bring the work of the great research departments of the nation, the state and the university within the grasp of the people to whom their results would be valuable, if spread abroad in terms suited to the layman's comprehension.

Scores of men are at work for the state, and for the nation, solving problems affecting industrial and commercial conditions, whose results never reach the people at large, or do so after costly delays. Much of this information is gathered at a cost of millions of dollars and would be of incalculable value if properly disseminated. It is not sufficient to determine in the laboratory that coal should be purchased on the basis of number of heat units in a pound, other things being equal, but this fact must be made known to coal users or buyers if it is to be of real value. Results obtained by experts and specialists to be of general use must be put into simple and direct form and brought to the knowledge of the people.

The need of the general public for nonpartisan and dispassionate information upon the live problems of the day, political and other; the want in many places of library facilities for the study of such questions, or in the presence of the library, the lack of knowledge of its contents and how to use them; also the demand from schools for aid in arousing the interest of growing boys and girls in the issues that are before the country, all point to a fruitful field of university service. The policy is surely questionable, at least, which leaves to the press and political orators the education of the public in matters so essential to its welfare, as, for example, election of senators by popular vote, good roads, the wheel tax, commission form of city government, the recall, etc.

Existing organizations, of which there are many—such as civic clubs, women's clubs, business men's clubs, commercial clubs, debating clubs, etc.—and groups of people needing only a suggestion to lead them to form themselves into bodies for study and discussion, are anxious to consider the newer questions of the day, but often do not know where to turn for advice and assistance. There should be available at the university for the use of these organizations, collections of classified reference material in the shape of newspaper and magazine articles, books, and state and national publications relating to those subjects, to be lent under definite regulations free of cost.

There should also be published and distributed bulletins formulating subjects for debate and containing full lists of references, negative and affirmative, with information as to where and how they may be obtained. State traveling library commissions should cooperate in the work. In fact, as traveling libraries have such an important relation to all university extension work, it is a question whether the traveling library commission should not have an organic relation with university extension.

Topical package libraries, adapted to

high-school work in preparation of graduation themes and debates may be used to awaken interest among boys and girls in current questions. It will be found that high-school teachers are glad to divert their students from the old stereotyped subjects to live modern ones, when it is not too difficult to obtain reliable and timely information.

The wisdom of the establishment of a municipal reference bureau as a university charge will not be questioned when it is remembered that in a little over one hundred years urban population in the United States has increased from two per cent. of the total population to nearly fifty per cent. So rapid a growth as this must tax the powers of the legislator to the utmost, and is sure to be accompanied by an amount of groping in the dark and experimentation that may be disastrous. Large cities can well afford to establish bureaus of their own, manned with experts in municipal government, but such a course is absolutely impossible for the smaller municipalities and rural districts.

There is a general awakening to the need for better urban government, and recognition that this country is far behind many foreign countries in city administration. But it is seldom that the council of a town or small city will take the trouble to gain or even feels the need for information regarding practises and results in other places.

A university offers exceptional facilities for carrying on this work. Ordinances collected and filed for reference, together with data relating to their effectiveness as working measures, will be conveniently available through extension division channels. And the same instrumentality will connect the municipality with the service in a purely advisory capacity of the university specialist in such departments as sanitation, hygiene, street lighting or paving, and all matters affecting the general welfare of the people.

Frequently, in great movements, much effort is wasted in the creation of interest and enthusiasm, which is not sustained because no agent is at hand to keep the impulse alive until it is crystallized into permanent form. The crusade against tuberculosis, the schoolhouse social center movement, and many other similar undertakings of vital and far-reaching effect upon large numbers, would be much more surely advanced if controlled by such organization as belongs to university extension, than is possible under the ordinary conditions of inertia or spasmodic attack, which characterize the average community.

The experiment of cooperation between the Anti-tuberculosis Association and the university has been tried with marked success, and the social center movement is also recognized as a suitable work for university promotion.

The bringing together in united interests of groups, diversified in racial, political, religious and social affiliations is a step tending toward a more genuine democratization of the American people than has yet been experienced in their life or their institutions. The use of the schoolhouse out of school hours and of the public playgrounds for the work and play of people of all ages appeals strongly to the wide-awake educator as an economical, sane and healthful measure, one that provides a remedy for evils that exist both in urban and rural communities. As an educational means, it probably needs, for the present at least, the fostering care of a strong organization, quite as much as any other field of extension endeavor. University extension should find in this civic and social center a suitable vehicle for its operations.

The machinery of university extension

may legitimately be used in conducting conferences of interest to certain classes of workers. These may include conventions covering several days, or institutes of several weeks' or months' duration. An organization having the resources of the university at its command can easily assemble specialists in some given subject as, for example, civic and social service, criminology or the scientific aspects of a craft. Lectures, demonstrations and informal discussions are directed toward plain and lucid exposition of the problems under consideration. Authorities, not only from the university, but from over the whole country may be drawn upon for these conferences, with the result that the work will be up-to-date, scientific, practical and comprehensive in its applications.

One of the most widely known and gifted extension lecturers in our country wrote a year or two ago of the university extension movement:

> Like all ideas and movements, it has fulfilled itself in unseen ways. It is no longer an occasional and accidental phase of university work; it is an organic part of it. It is no longer concerned merely or primarily with short lecture courses, for without neglecting the lecture work that appeals to general audiences, it aims to reach, like any other part of the university, a student body . . . the very large body of partial or non-resident students.

Examination into the status of extension teaching in the United States discloses a remarkable broadening and liberalizing of the academic spirit. The fact that a number of the old conservative universities now offer extra-mural teaching with no more stringent specifications than that the applicant shall be able to show that he can take the work to advantage, is evidence of a notable change in their educational atmosphere.

The uniting of the eight leading educational institutions in and around Boston, including Harvard, Tufts, the Massachusetts Institute of Technology and others, into a Commission on Extension Teaching, denoted a striking departure from the old conception of higher education. The fact that these institutions have agreed upon a course of instruction leading to the degree A.A. (associate in arts) with no entrance examination or resident work requirements, is evidence of a radical readjustment of viewpoint among educators.

The cost of extension teaching, state-wide in its application, must necessarily seem formidable, but it must be recognized that not only does the system promise a degree of amelioration of economic and other conditions, but gives immediate and substantial returns in increased productive power of the trained over the untrained worker.

In 1907–08, according to the Commissioner of Education, the sum of $66,790,924 was spent in giving higher education in the United States to 265,966 persons. In the state of Minnesota $1,880,568 were spent in the same year for the education of 6,743 persons. No one acquainted with the facts will question the wisdom of this expenditure. Educated leadership is essential; the results of research as conducted in institutions of higher learning are far reaching, the value incalculable. Yet, if the state university is in truth a public service corporation, is not the public justified in demanding that this great expenditure be made to serve the entire state as its student body? Nor should the fact be overlooked that the extra-mural activities of university extension create an attitude in the people of the state, that will not fail to be reflected in greater loyalty and more generous financial support—conditions that may be counted upon not only to insure the spread of university benefactions, but to more rapidly advance the interests of the

conventional and long-established forms of higher educational work.

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AN OPPORTUNITY FOR THE SPIRIT OF RESEARCH IN LABORATORY INSTRUCTION IN PHYSICS

A ritual does not require worship; a system in laboratory instruction does not demand the investment of the personality of the instructor. A smoothly operating system is a delight to the mill owner or to the manufacturer. According to general practise, such a system affords the modern laboratory instructor in physics a great deal of satisfaction.

But has not laboratory instruction in physics become enslaved to laboratory methods? The fundamental purpose of such instruction should be decided in the light of its origin. At first the laboratory work was not prescribed in the course of study. Magnus[1] in Berlin conducted such a laboratory. The experiments performed were of an investigational nature. Some of his pupils were G. H. Wiedemann, Helmholtz and Tyndall. Later, Lord Kelvin,[2] at Glasgow, entered upon certain investigations of the electrodynamic qualities of matter and, finding the labor of observing too heavy for one individual, invited certain students to aid in the work. Other students desired experimental work of a similar nature and thus was developed a research laboratory in which the students took an enthusiastic interest. The funds of this laboratory were obtained from the university, but, in the beginning, there was no systematic instruction of students similar to that in the laboratories of to-day.

As these two illustrations indicate, the student's physical laboratory had its origin in research. The zeal for new knowledge furnished the enthusiasm and prescribed the methods of work. To-day, apparently, the student enters the laboratory to learn how to perform experiments and to become expert in the use of various devices such as the micrometer microscope, or the optical lever, or the dividing engine, and to familiarize himself with certain methods of measurement, such as the method of coincidences or the method of double weighing. Indeed, quite frequently courses have such titles as "Laboratory practise" and "Electrical measurements."

Jesus claimed that the Pharisees tithed mint, anise and cummin, but neglected the weightier matters of the law. One can not deny the virtue of tithing; neither can one fail to appreciate the educational value of an experiment which requires great care and accuracy on the part of the student. But what about the weightier matters? The chief function of the laboratory is to give the student an intimate acquaintance with the phenomena and the so-called laws. The familiarity of the student with a particular instrument or method is of temporary importance and should be of little interest. Indeed, why should accurate measurements be considered so highly desirable? Do not the thoughtful regret the fact that in the progress of physics so much valuable time must be spent in accurate measurements by the investigators? Does not the physicist seek to obtain the accuracy needed in a particular investigation with the least amount of painstaking effort, and therefore the least time and labor? Accurate measurements are found in research because they are needed to obtain results, and not because they are intrinsically worthy of a scholar's time and attention. Let this be the recognition of accurate measurements in the laboratory of the student.

The Pharisees thought that they were right, and doubtless their attitude can be explained by the powerful influence of tradition. The defect in our present laboratory instruction can be explained in a similar manner. The instructor accepts the laboratory as an approved method of instruction and is not continually conscious of its highest function. The student working under his direction is just "doing laboratory work."

The slavery to method can be resisted only where the true spirit of research is supreme.

[1] Cajori, "History of Physics," p. 291.

[2] From Kelvin's Bangor address, quoted in Gray's "Lord Kelvin," p. 71.

This is the remedy. In a laboratory where such a spirit is always in evidence, the methods and devices become of secondary importance and the emphasis is placed upon weightier matters. This spirit will be maintained only by eternal vigilance. Is this possible other than by means of active research?

The needed reform in laboratory instruction in physics does not demand radical changes in equipment, but it insists that the instructor shall have the spirit of the science, and that he shall minimize the importance of method and magnify the real function of the laboratory. It is useless to claim that the remedy lies in a particular set of experiments or in the proper equipment. Any method or any equipment will eventually enslave the teacher if it is permitted to do so. The remedy lies wholly in the attitude of the instructor. The teacher who has not the true spirit of research can not obtain freedom from slavery to method.

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A NEW GAS VOLCANO IN TRINIDAD

The daily press recently reported that a new island had been thrown up near the coast of Trinidad, with accompanying fire and explosions. This report and the statement appearing in numerous places that the eruption was volcanic has strengthened the impression, already somewhat current, that Trinidad is a volcanic island forming part of the same chain as Martinique, St. Vincent and others of the Windward Islands. There is, however, no true volcanic activity in Trinidad and no volcanic rocks either recent or ancient are known there. The island is formed of highly folded sedimentary and metamorphic strata, and is more properly to be considered as a portion of the South American land mass. The recent eruption near its south coast was due to the sudden escape of a large quantity of gas from the strata that form the submerged coastal plateau, with the consequent ejection of the mud and other materials which had hitherto confined the pressure. Eruptions of this type on a small scale are constantly going on in southern Trinidad, forming the many mud cones and craters to be seen there, and occasionally large outbreaks such as this latest one occur. In all cases the force at work is escaping gas which rises from the gas-bearing sandy and clayey strata, bringing with it fine sediment and salty water derived from these beds.

I visited numerous gas volcanoes in this portion of Trinidad during October but left there just before the recent eruption took place. Mr. Jefferson D. Davis, of Port of Spain, in a letter dated November 6 writes as follows:

> On last Saturday (Nov. 4) land was seen to rise from the surface of the ocean 3 miles southwest of Erin. . . . The gas . . . soon took fire, and the flames must have gone to an enormous height, because they were seen from Port of Spain to shoot into the clouds, and Erin is approximately fifty miles from this place. The country was lit up for considerable time, and great consternation prevailed among the natives. . . . The governor of the colony and a party of officials with a number of prominent people from this place went down yesterday to see the phenomenon, and found a piece of land about three acres in area, about thirty to forty feet above sea-level, in the center of which was a crater. The ground seemed to be the ordinary blue mud, but was very hot, consequently baked dry and hard. Some of the more adventurous visitors went on to the land and walked about for a while, and took home some samples of the clay. Large volumes of gas were coming from the crater at this time, but there was no fire. We learned to-day by telephone that it has taken fire again.

It is also reported that four distinct detonations were heard from Port of Spain after the island had been formed and that the fire continued burning until Sunday morning. Mr A. C. Veatch, formerly of the U. S. Geological Survey, was on board ship at Brighton, Trinidad, just about to sail for New York at the time. He informs me that his notice was suddenly attracted by a great flame that shot up into the sky just at dusk, at ten minutes before six, Saturday evening. Every one thought it was an oil or gas well on fire. With

the first puff the flame rose as a brilliant mushroom-shaped mass, which immediately changed its form to a straight jet of fire that must have risen to a height of at least 1,000 feet. No noise whatever preceding or accompanying the fire was to be heard from Brighton, which is across the low hills within fourteen miles of the place where the new island was formed. The fire disappeared below the horizon in about five minutes, leaving a cloud of smoke that drifted away. No light was to be seen in the sky the rest of the evening, which makes it certain that the flame either became reduced to a very small size or died out entirely.

The point at which this new gas volcano burst from beneath the sea is about two miles off the south coast of Trinidad. The water is shallow and banks are shown in the vicinity on some maps. On one of these banks asphalt is reported to exist. It is likely that gas springs and mud cones have previously existed on the sea floor in the vicinity. The vent lies along the eastward extension of an east-west line of active gas volcanoes and oil springs that traverses the southeastern tip of Trinidad. This line is mapped by Mr. Cunningham Craig, formerly government geologist of Trinidad, as an anticline. Another assumption that may be considered equally tenable is that the gas volcanoes and asphalt cones may follow a zone of faulting. The strata are highly tilted and contorted and afford little definite evidence as to the character of the structural line. The Columbia volcano, the largest of the gas volcanoes in this belt, has formed a broad mound many acres in extent and 50 or 70 feet in height. An explosion had occurred there just a few days before my visit, in the latter part of October, and thrown up a mass of mud around the crater that increased the height of the summit several feet. The sides of this cone as well as of some others in Trinidad, notably the one called "The Devil's Woodpile," are strewn with pebbles and rock fragments that have been ejected from a great depth.

A point of unusual interest regarding the late eruption is that the gas took fire. The reports so far received give no details bearing on this point, but it seems unlikely that the original ignition took place through human agency. If it did not the phenomenon is one which has seldom if ever been recorded before. Two ways suggest themselves in which the gas might conceivably have become ignited through natural causes. One way is that sparks might have been produced by the friction of boulders against each other as they were shot out with the gas. Cases have been reported to me by oil men in which sparks were formed by boulders, projected under great gas pressure from wells, striking the casing and tools, but I have heard of no case in which the gas was lighted. Another supposition is that electric sparks might have been generated similar to those observed in the vapor clouds emanating from Mount Pelée at the time of its great eruption.

Robert Anderson

THE FUTURE OF THE LONDON ZOOLOGICAL GARDENS

From time to time suggestions have been made respecting the transference of the menagerie of the Zoological Society of London to a more suitable site; and naturally when the fate of the Crystal Palace has been engaging the attention of the public, it has been urged that to make it the headquarters of the Zoo would solve the difficulties of both institutions. Certainly the clay soil at Regent's Park is not specially suitable for animals, although it is not as serious a disadvantage as is sometimes supposed.

A chief difficulty with animals in confinement is that the ground on which they are placed rapidly becomes contaminated with organic refuse, and so forms a suitable nidus for harmful bacteria. Whatever the soil may be, it is necessary, in a majority of cases, unless an enormous area is available, to cover it with an impermeable surface; and this treatment is at least as urgent in the case of sand and gravel as in that of clay. The present area of the gardens in Regent's Park is about

34 acres, and more space would make many improvements possible.

A very large increase of space, however, is not necessary. If the government departments concerned would allow the society to use another 20 or 30 acres of the park on lines similar to those suggested in the columns of *The Times* in July last, there would be ample space for the exhibition of animals on the most modern lines. It is impossible to combine satisfactorily an exhibition ground with a place for the breeding or recuperation of animals. For the convenience of visitors, and children especially, the total area of a zoological garden should not be too great; and, if animals are to be seen satisfactorily, they must not be placed in enclosures large enough to let them retreat from the public gaze. On the other hand, for breeding, acclimatization and the recuperation of animals at all out of health, large secluded areas away from the smoke and fumes of a great city are necessary. An ideal menagerie, whether placed in Regent's Park or at the Crystal Palace, should have also a much larger station in the country where visitors are not allowed.

The cost of installing the Zoological Gardens on a new site would be very great. Even if the provisions of the London Building Act could be got over, and the designs for new Zoological Gardens made simple and suitable with regard to structure and material, the total cost of installation, apart from the cost of the animals and the cost of the ground, would reach at least a quarter of a million pounds. Then there is the question of revenue. Regent's Park, it is true, has been rather passed by in the recent changes that have taken place in London passenger traffic; but even with this disadvantage the average annual gate-money now exceeds £20,000, while the income from the subscriptions of fellows approaches £10,000, and is increasing yearly. Access to the Crystal Palace has certainly been much improved, but it is still difficult to get there by rail, while the roads leading to it are among the most congested in London.

Finally, neither the proprietors of the Crystal Palace nor the Zoological Society of London can consider the finances entirely from the point of view of a public menagerie. The Crystal Palace would require a large income to meet interest on capital and various expenses, and it would look for assistance from the revenue earned by the menagerie. In the case of the Zoological Society, the maintenance of a popular collection of living animals, although the chief source of revenue, is only a part of the duty of the society. The introduction of animals of interest only to maturalists, the encouragement and direct assistance of zoological exploration throughout the world, the maintenance of a magnificent zoological library, and holding of meetings for the discussion of technical zoological subjects, and the publication of memoirs containing the results of zoological investigation are an essential part of the operations of the society, and one very difficult to combine with a place of general popular entertainment.—London *Times*.

SCIENTIFIC NOTES AND NEWS

Sir Joseph Dalton Hooker, the great English botanist, has died in his ninety-fifth year.

Dr. George Davidson, eminent for his contributions to geodesy, geography and astronomy, emeritus professor in the University of California, has died at the age of eighty-six years.

Funeral services of the late Surgeon-General Walter Wyman, U. S. Public Health and Marine Hospital Service, were held in St. Louis in the First Presbyterian Church on November 24. On December 3, there were memorial exercises in San Francisco. A special memorial number of the *Weekly Bulletin of the St. Louis Medical Society* is to be issued in memory of Dr. Wyman.

The Nobel prizes were awarded by the King of Sweden on November 10. The three recipients in the sciences, Mme. Marie Curie, of the University of Paris; Professor Wilhelm Wien, of the University of Würzburg and Professor Allvar Gullstrand, of the University of Upsala, were present to receive them.

Professor John Henry Comstock, head of

the department of entomology at Cornell University, has been elected an honorary fellow of the Entomological Society of London.

A PORTRAIT of Dr. John A. Wyeth will be presented to the gallery of presidents of the New York Academy of Medicine by subscription of members.

A PORTRAIT of Professor James Geikie, subscribed for by members of the Royal Scottish Geographical Society, was unveiled by the president at the meeting of the society on November 11. A replica of the portrait was presented to Mrs. Geikie.

MR. C. O. LAMPLAND, of the Lowell Observatory, has recently been elected an honorary member of the Sociedad Astronomico de Mexico and Mr. E. C. Slipher, of the same observatory, has received its medal for his planetary photographs. Dr. Lowell has been an honorary member and a medallist of the society for several years.

PROFESSOR HENRY M. HOWE, of the department of metallurgy, Columbia University, has been elected honorary member of the Cleveland Institution of Engineers, Great Britain.

MR. N. C. NELSON, instructor in anthropology in the University of California, has been appointed assistant curator in the department of anthropology in the American Museum of Natural History. He will assume his duties next June and give special attention to North American archeology.

PROFESSOR J. KÖNIG has retired as director of the agricultural experiment station at Münster, after 40 years of service and has been succeeded by Professor A. Börner, formerly vice-director.

NAVAL CONSTRUCTOR HOLDEN A. EVANS has resigned from the navy to become vice-president of a shipbuilding company.

PROFESSOR RICHARD T. ELY, head of the department of political economy of the University of Wisconsin, has been appointed to represent the United States on the international commission appointed to study government crop reporting in Europe and America, by the International Statistical Institute, recently held at The Hague. Statisticians generally have long been dissatisfied with the character of crop reports, and the purpose of the commission is to bring about an accurate and uniform method of crop reporting in all countries.

PRESIDENT H. S. DRINKER and Professor J. W. Richards, of Lehigh University, were among the thirty-eight engineers who attended the recent meeting in Japan of the American Institute of Mining Engineers.

ASSOCIATE PROFESSOR CHARLES J. CHAMBERLAIN, of the department of botany of the University of Chicago, is at present doing research work in the far east. In the course of his investigations Professor Chamberlain will visit eastern and southern New Zealand, eastern and western Australia and southern and western Africa.

PROFESSOR WALTER B. CANNON, of Harvard Medical School, gives the sixth of the Harvey lectures at the New York Academy of Medicine on December 16, his subject being "A Consideration of the Nature of Hunger."

PROFESSOR ERIC DOOLITTLE delivered a lecture before the University of Pennsylvania Chapter of the Sigma Xi, on December 11, in the Randal Morgan Laboratory of Physics. His subject was "The Recent Discoveries in Stellar Astronomy."

THE memory of Benjamin Franklin, founder in 1740 of the University of Pennsylvania, is to be honored by the erection of a bronze statue at a cost of $10,000, on the tenth anniversary of the class of 1904, college, in June, 1914. The statue will be placed in front of the gymnasium on Thirty-third Street, near Spruce. The statue will be of heroic proportions, and will represent Franklin as he first appeared in Philadelphia as a runaway printer's apprentice. It has been modeled by Dr. R. Tait McKenzie, professor of physical education, who has modeled several medallions for the university and figures of athletes which have attained celebrity for their lifelike postures. The base of the statue has been designed by Professor Henry Cret, of the architectural school.

In memory of Mungo Park and Richard Lander, who explored the course of the river Niger, it is proposed to erect an obelisk of similar design and dimensions to Cleopatra's Needle, on a projecting point of land at Forcados.

Professor Stöhr, director of the Anatomical Institute at Würzburg, died on November 4, aged sixty-two years.

The death is announced of Dr. F. Bente, director for many years of the control station for fertilizers, feeding stuffs, foods and seeds at Ebstorf, Prussia.

Professor Alfred Cole, secretary of Section B, writes that at the annual meeting of the American Association for the Advancement of Science, at Washington, December 27–30, 1911, Section B (physics), will, as usual, hold joint sessions with the American Physical Society. The place of meeting will be at the Bureau of Standards. The ordinary program of papers will be in charge of the officers of the Physical Society, but the two sessions on Thursday, December 28, will be devoted to papers of more general scientific interest and will be in charge of Section B. At the forenoon session of that day the address of the president of the Physical Society, Professor W. F. Magie, will be given, the subject being "Primary Concepts of Physics." This will be followed by a symposium on "The Ether," led by Professor A. A. Michelson, who will be followed by Professor A. G. Webster, C. E. Mendenhall and others. At the afternoon session there will be the address by the retiring chairman of Section B, Professor E. B. Rosa, on "The Work of the Electrical Division of the Bureau of Standards"; a paper by Professor H. A. Wilson, of Montreal, on the "Structure of the Atom" and (probably) one by Dr. S. W. Stratton, on "Physical Work at the Bureau of Standards." Other addresses of special interest to physicists will be that of Professor A. L. Rotch before Section D on "Aerial Engineering" (unfortunately set for Thursday afternoon) and that of the retiring president of the American Association, Professor A. A. Michelson, on "Recent Progress in Spectroscopic Methods," on Wednesday evening, December 27, at 8 P.M. The New Ebbitt House is selected as hotel headquarters for physicists. It is located at 14th and F Streets. Rates, European plan, $1.50 without bath, $2.00–$2.50 with bath. At recent meetings the plan of getting together at one hotel has added much to the pleasure and profit of the meeting. It would be well to reserve hotel accommodation at once. Abstracts of papers to be presented should be sent as soon as possible to the secretary of the Physical Society, Professor Ernest Merritt, Cornell University, Ithaca, N. Y. The program of the meeting will be mailed on December 15. Except by special action of the program committee, no more than ten minutes can be allowed for the presentation of each paper. Attention is also directed to the council rule which *forbids the secretary to place a title upon the program until an abstract (not necessarily for publication) is in his hands.*

The thirteenth meeting of the Astronomical and Astrophysical Society of America will be held at the Carnegie Institution, Washington, D. C., on Wednesday, Thursday and Friday, December 27–29, 1911. This particular time and place have been chosen for an extra meeting for the purpose of bringing the society both as individuals and as an organization into closer touch with the American Association for the Advancement of Science. A joint session with Section A of the American Association for the Advancement of Science has been arranged for Friday morning. The program of this session will include the address by the retiring chairman of Section A, Professor E. H. Moore; a paper on the "Asteroid Problem," by Reverend J. H. Metcalf, and probably, also, a paper by Professor Lewis Boss on his recent stellar researches. On Wednesday evening there will be a reception at the Naval Observatory tendered by the superintendent and staff to the officers and members of the society. On Thursday afternoon the members will visit the Astrophysical Observatory of the Smithsonian Institution.

The dates for sessions of the American Physiological Society in Baltimore are December 26–29. The council meets in the evening, December 26, and the scientific sessions begin in the morning, December 27, and continue through the morning of December 29. The session in Washington in connection with Section K is planned for the afternoon of December 29. Arrangements are being made for a symposium on *Acapnia and Shock* for this joint session. The headquarters in Baltimore will be at the Hotel Rennert, corner of Liberty and Saratoga streets. Arrangements have been made by which members of the three societies (Physiological, Biochemical and Pharmacological) meeting in Baltimore may dine together at the headquarters on Wednesday and Thursday evenings, and it is proposed that on both evenings the dinner shall terminate in an informal smoker. The scientific sessions of the society will be held in the physiological building of the Johns Hopkins Medical School. Announcement of papers for the Baltimore sessions have been received from the following members: E. B. Meigs, D. E. Jackson, W. E. Garrey, Th. Hough, J. Erlanger, G. Lusk, H. Cushing and C. Jacobson, Y. Henderson, W. P. Lombard, W. Salant, J. A. E. Eyster, A. S. Loevenhart, L. B. Mendel, W. J. Osterhout, C. Brooks, J. J. R. Macleod, R. E. Sheldon, C. J. Wiggers, W. J. Meek, F. S. Lee and A. E. Guenther, F. S. Lee and M. Levine, E. M. Ewing and H. C. Jackson, H. McGuigan, C. W. Edmunds, G. W. Crile, G. W. MacCallum, J. Auer, S. A. Matthews.

The third annual meeting of the Paleontological Society will be held in the New National Museum building, Washington, D. C., beginning on Thursday morning, December 28, at 10 o'clock. President William B. Scott will preside over the meeting. The program includes a conference on Friday on Ten Years' Progress in Vertebrate Paleontology with papers as follows:

Wm. B. Scott: South American Mammals.
W. D. Matthew: African Mammals.
O. A. Peterson: Artiodactyla.
J. W. Gidley: Perissodactyla.
W. D. Matthew: Carnivora and Rodentia.
W. K. Gregory: Primates, Marsupials and Insectivores.
F. W. True: Marine Mammals.
E. C. Case: Paleozoic Reptiles and Amphibia—a Comparison of Old and New World Forms.
W. J. Holland: Pre-cretaceous Dinosaurs.
R. S. Lull: Cretaceous Dinosaurs.
O. P. Hay: Chelonia.
J. C. Merriam: Marine Reptiles.
Bashford Dean: Paleozoic Fishes.
C. R. Eastman: Mesozoic and Cenozoic Fishes.
H. F. Osborn: Correlation and Paleogeography.
S. W. Williston: Evolutionary Evidence.
W. J. Sinclair: Contributions to Geologic Theory and Method.

Each of these papers is to discuss the following points: (*a*) status of our actual knowledge, and principal material in different museums which has been brought together in recent years: (*b*) theories accepted and rejected in recent years; (*c*) hypotheses on trial; (*d*) important investigations and explorations which should be made.

We are requested by the chief of the Weather Bureau to announce that in connection with the Washington meeting of the American Association for the Advancement of Science an informal gathering of persons interested in meteorology and kindred subjects will be held at the Weather Bureau buildings, 24th and M streets, N. W., Thursday afternoon, December 28, from 5 to 7 P.M. The location is easy of access viâ the Pennsylvania Avenue car-line, by which many members of the association will be returning from the cavalry drill at Fort Myer, the same day. The drill is from 3 to 4:30 P.M. The proposed gathering will be analogous in character and purpose to the "meteorological luncheon" of the British Association, and its promoters hope that a meeting of this kind may become an annual event. A series of five-minute talks will be given by leading men of science on the general subject, "The Relation of Meteorology to other Sciences." The scope of the discussion will be broad enough to interest every one, and it is hoped that the attendance may be general on the part of members of the association and

their friends, including ladies. The visitors will be given an opportunity of inspecting the installations and work of the bureau.

THE annual meeting of the American Anthropological Association in affiliation with Section H of the American Association for the Advancement of Science and the American Folk-Lore Society will be held December 27–30 in Room 28, U. S. National Museum (new building), Washington, D. C., instead of in the Public Library as previously announced.

NEARLY a hundred students from the College of Engineering of the University of Wisconsin are now on their yearly tour of inspection of great engineering plants of the east. Engineering plants in Chicago, Milwaukee, Niagara Falls, Pittsburgh, Schenectady, N. Y., and New York City will be visited. These tours are required of students of engineering during their junior and senior years and are arranged to cover industries that illustrate the work of the course pursued by the student. Professors A. G. Christie, George J. Davis, J. R. Price and A. L. Goddard accompany the students on the trip.

A SITE for the Memorial Institute for Infectious Diseases, Chicago, to be built with funds bequeathed by Mrs. Annie W. Durand, has been selected and purchased at the corner of Wood and York Streets with a ground area of 100 by 126 feet. The building will be four stories and a basement in height and will cost with its equipment about $200,000.

UNIVERSITY AND EDUCATIONAL NEWS

WILLIAMS COLLEGE will receive approximately $100,000 by the will of Miss Sarah H. Pattison, of Ossining, N. Y. The money is to be used for the library.

THROOP POLYTECHNIC INSTITUTE, at Pasadena, California, through the generosity of an anonymous donor, has announced two annual prizes—a senior scholarship prize of $750, to be used for a trip to Europe, and a freshman scholarship prize of $250, to be used for a trip through some of the principal cities of the eastern United States. The senior prize will be awarded to the student who has the best record in scholarship for the junior and senior year, "the faculty taking also into account, in assigning the award, considerations of deportment or good manners and ability for original work." The freshman prize will be awarded to the freshman who has the best scholarship record for the year, "good manners and the quality of initiative being also taken into account."

THE official list of changes in the instructing staff of the Massachusetts Institute of Technology shows that there have been forty-three replacements of last year's professors or instructors plus five additions, forty-eight new men. Chemistry and electric engineering are the departments in which the largest additions have been made. In chemistry the changes include the promotion of five instructors or assistants and the addition of six. In electrical engineering three additional instructors may be noted.

THE following appointments have been made at Cornell University: Herbert A. Hopper, assistant professor in extension work in animal industry; T. E. Schreiner, assistant in the department of poultry husbandry; G. H. Miller, assistant in pomology for the winter course; William C. Hooey, assistant in chemistry.

DR. M. T. COOK has resigned as plant pathologist in the Delaware Station to become professor of plant pathology in Rutgers College and plant pathologist in the New Jersey College Station.

MR. FRANK E. HERMANNS has been made the head of the structural engineering department at the Stevens Institute of Technology.

AT Cornell University the work in farm management has been organized as a separate department, with G. F. Warren as head, K. C. Livermore as assistant professor and A. L. Thompson as instructor. The work in farm crops has been united with the department of farm practise and is in charge of Professor J. L. Stone.

MR. H. A. WADSWORTH has been appointed assistant professor of forestry in the school of forestry of the University of Idaho.

DISCUSSION AND CORRESPONDENCE

"GENOTYPE" AND "PURE LINE"

The widespread interest in the lectures on genetic problems now being given in this country by Professor W. Johannsen makes it worth while to point out certain diversities in the usage of terms introduced by him—diversities giving an appearance of disagreement where none exists. The fact that the present writer is partly responsible for any confusion thus caused impels the publication of this note.

The term *genotype* was introduced by Johannsen in connection with the term phenotype. The latter designates a group of organisms which in outward appearance seem to belong to one type, although in hereditary constitution they may actually differ greatly. *Genotype,* in Johannsen's usage, is not directly contrasted with phenotype, to signify a group of organisms that actually do possess in all respects the same hereditary constitution—though this is the sense in which some of us have been using it. It arose as follows. Organisms with hereditarily different constitutions must have different combinations of the determiners, called by Johannsen *genes,* that decide what the somatic characters shall be. They have, then, different typical combinations of genes. Johannsen calls the particular combination of genes that an organism has, its genotype. Or, without reference to genes, we might say that the genotype of any organism is the particular combination of hereditary features that characterize it. Thus, as employed in Johannsen's usage, genotype is an abstract term.

When a group of organisms all have demonstrably the same combination of hereditary characteristics, one can say that they have the same genotype, or that they belong to the same genotype. From this it is but a step to the employment of the word as a name for such a concrete group of organisms, all with the same hereditary characteristics. Following a bent toward concreteness, I have used the term in this way in my paper on "Pure Lines in the Study of Genetics in Lower Organisms."[1] Shull has done the same in his paper on the "Genotypes of Maize";[2] apparently this use of the term for a concrete, visible group of organisms is becoming general; for a term with this precise meaning is much needed. But this is not the usage of Johannsen.

Thus arise such differences as that shown by my own characterization of genotypes as "concrete realities," as "actual existences that strike you in the face," etc.,[3] when compared to Johannsen's statement that "we do not know a genotype," etc.,[4] and that this is a concept with which we cannot actually operate.[5] There thus arises an appearance of opposition where none exists. What I and some others have called a genotype is what Johannsen would call a group of organisms "identical in genotypical constitution." The usage recommended by the originator has of course the right of way.[6]

A diversity of usage likewise exists as to the expression "pure line." I have employed this to designate a genealogical series in which there arises no diversity in hereditary characteristics, either from within or from without; such, for example, as the series produced by the repeated fission of a single infusorian. Pure lines in this sense might be expected, from what we thus far have learned, (1) in cases of vegetative reproduction, (2) in at least some cases of parthenogenesis (where no reduction division occurs), (3) in case of self-fertilization of homozygotic organisms, (4) in case of inbreeding of a group of genotypically identical homozygotic organisms.

The pure lines investigated by Johannsen fall in the third group, and he employs their

[1] *Amer. Nat.*, February, 1911.

[2] *Amer. Nat.*, April, 1911.

[3] *L. c.*, p. 80.

[4] *Amer. Nat.*, March, 1911, p. 134.

[5] "Elemente der exakten Erblichkeitslehre," p. 130.

[6] Whether the word itself should be given up, in this connection, because it had earlier been used in an entirely different sense, is of course a different question.

characteristics as his definition for pure line. "A pure line may be defined as the descendants from one single homozygotic organism exclusively propagating by self-fertilization."[7] It appears that we need badly a term that will include "genotypically identical" series of forms arising in other cases than this one, so that it is difficult to give up the use of the term in this wider meaning.

H. S. JENNINGS

MOSQUITO ROMANCE

IN the issue of SCIENCE for September 15, pp. 350–351, Dr. John B. Smith reviewed a book by Edward H. Ross—"The Reduction of Domestic Mosquitos." While Dr. Smith indicates that the book does not meet the general needs of those to whom the title is obviously meant to appeal, he intimates that it will be valuable "in warm climates." Other reviews of the book have appeared in terms of unqualified praise. The most recent of these is in the November number of *Entomological News.* Furthermore, the book has been well advertised among those who might need useful information on this now important subject. Under the circumstances the writer considers it his duty to protect fellow-workers by indicating the true character of the book.

The author restricts himself to the two principal house-mosquitoes of the tropics, *Stegomyia calopus* and *Culex fatigans*, and the problem of their control. But instead of facts we get an array of well-worn generalities, and, where he deals with the life histories of the insects, of pure fabrications. It would be a waste of valuable space to discuss this book *in extenso;* a few choice blossoms are culled herewith for the benefit of the uninformed.

The book is avowedly economic and biological, but, lest the reader think the systematic side is negligible, we quote the following: "Fabricius in 1805 first designated the 'tiger' mosquito, *Stegomyia fasciata,* although Villiers[1] had probably described the same insect before; Meigen called it *Stegomyia calopus* very soon after. In 1825 Latreille grouped mosquitos generally under the name Culicidæ, but only three genera were known, *Anopheles, Culex* and *Ædes.*" Alas for Meigen and for Theobald!

Chapter II. deals with "the life and habits of mosquitos." One of the first statements we find here is that "the hæmatophagous habit appears to be dependent on the presence, in the female, of the spermatozoa of the male." The author deduces this from the fact that all the females with blood in the stomach dissected by him contained spermatozoa in the spermathecæ. "From this it must be inferred that virgin females do not, commonly, take blood"—surely a simple piece of reasoning! We are then favored with some amusing speculative remarks on this unusual phenomenon. A most remarkable belief of the author is that the female *Culex,* after disposing of her eggs, seeks another male and, after being again fertilized, produces another raft of eggs, and then over again, apparently *ad infinitum.* This absurd belief is, of course, purely a product of the author's imagination and it is controverted by a formidable array of established facts, of which, however, our author is blissfully ignorant. Considerable space is taken up with the reiteration of this notion and the author returns to it again and again. "If a female lays a whole egg-raft or complete brood, she exhausts all the spermatozoa within her spermathecæ and then she must again cohabit with a male in order to be replenished. This is the reason why males are likely to remain in or resort to the places where the females commonly lay their eggs. For example, in houses, the males of the Culecines are commonly found in the water-closets. The females are attracted there by the seal-water,

[7] Johannsen, *Amer. Nat.,* March, 1911, p. 135.

[1] The author's name is de Villers. He described a *Culex fasciatus* in 1789. Independently Meigen, in 1804, and Fabricius, in 1805, described other mosquitoes under the same name. The last of these was the species here considered, but the name is preoccupied by the two earlier homonyms; consequently (*Culex*) *calopus,* the name under which it was later described by Meigen, had to be adopted. The genus *Stegomyia* was established by Theobald in 1901.

for they know that their children will thrive therein; and also that as soon as they have laid their eggs the males are ready to fertilize them again. The eggs exude their larvæ into the seal-water of the closet, the latter are washed down into the cesspool where the water is at an even temperature, and where there is plenty of food for them; so the perpetuation of the species is assured. As the female lives so much longer than the male, her second and third fecundations are brought about by the males of succeeding generations to her own." With modern improvements an up-to-date female mosquito does not even lose time by going down stairs to dispose of her eggs! Further interesting information is that "the larval metamorphosis includes the pupa stage." Most opportune comes the statement: "Both the larva and the pupa are not fish, but insects." *Notonecta* is well known as an enemy of mosquito larvæ and we here learn that "it can hop from one puddle to another. It is a water-beetle, but is rendered powerless against mosquito larvæ when the pond becomes full of green weed, which hampers its movements."

But the acme is reached in Chapter IX., entitled "Mosquito Reduction." This chapter does not, as one would suppose from the title, give useful instruction in the control of mosquitoes. Casting aside the fetters of science, the author soars into the boundless realm of pure imagination. He takes an imaginary female mosquito from the time she emerges from the pupa, through a series of hair-raising adventures, to the end of her life. The story is made fascinating by the author's treatment of mosquito psychology. "The room was almost dark. She settled at once on the mosquito net, waving her hind-legs in an expectant way. The thoughts of a meal made her feel a pleasurable excitement, but she also felt, instinctively, the need for caution." . . . "The wind and disturbance he made with his arms caused the mosquito to fly away to a far corner of the room, and contemplate with quaking thoughts the difficulties of obtaining the necessaries of life." . . . "When on the child's net she noticed that there were a score or so of mosquitoes like herself, with their bodies distended with blood. But there were only two males among them, and they both belonged to an alien species, and they had not fed on the child. What had become of the swarms of males that she had left in the cesspool? She wondered why it was only her sex that required blood. Why had she to risk her life for food while her husband and brothers remained contentedly in their home, the cesspool?" After a series of blood-letting and egg-laying adventures, in which our mosquito shows a considerable capacity for acquiring wisdom, we finally get to the point of the story. The mosquito brigade has been busy, the breeding places have been either oiled, drained or screened.

"Six weeks later she had another brood of eggs to lay. The fountain was now dry. She searched high and low, but there was no water anywhere that was suitable for her eggs; also there were no male mosquitos. All the cesspools contained petroleum, and even the cisterns were screened with wire gauze. So she laid her eggs in some clean water in a basin, but the larvæ died for want of food. She searched for a male mosquito of her species to consort with again; he could not be found. There were no mosquitos at all. Then the craving for blood seemed to forsake her. She became a vegetarian, living on the juices of old banana skins and discarded watermelons. But her life, once so full of adventure, was blasted, and she died disappointed, but with the knowledge that she had lived."

It should be added in closing that several chapters are devoted to directions for making estimates of cost for mosquito-control work, and principally how to wheedle the necessary money out of reluctant authorities, corporations or private individuals.

The appearance of the present work is the more astounding when one compares it with another work which appeared six years ago, as a byproduct of similar activity to Mr. Ross's and in the same locality (the Isthmus of Suez). The work referred to is Dr. Pressat's "Le paludisme et les moustiques" (Paris, Masson et Cie, 1905) which must still be

looked upon as a standard in this class of literature.

KONOPS

HOW A FALLING CAT TURNS OVER IN THE AIR

To the Editor of Science: In a lecture on the gyrostat before the Washington Society of Engineers, I gave a valid explanation of how a cat is able to light on his feet when he is dropped back downwards. After the lecture Professor J. F. Hayford was kind enough to call my attention to what is no doubt the actual character of this cat performance, and I give a statement of it herewith for the readers of Science. However, I prefer the idea I had formerly of the cat performance, because I am able to do it myself, not indeed while falling through the air but while standing on a pivoted stool. It is my impression that the idea I had formerly is the generally accepted idea of the cat performance, but it is difficult to explain, although easy to perform.

The curved figure in the accompanying sketch is a conventionalized cat which is let fall back downwards, and the question is how can a cat (not so highly conventionalized) turn over and light on its feet.

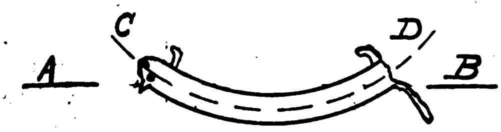


Fig. 1

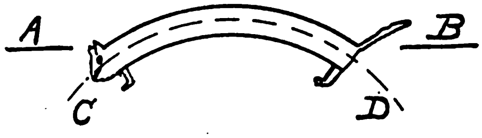


Fig. 2

There are two simple types of motion of the cat's body which give spin momentum around the axis AB, namely, (a) a rotation around AB as an axis of the cat's body as a rigid structure, and (b) a sort of squirming motion in which each part of the cat's body rotates about the curved line CD.

The amount of spin momentum due to a spin velocity a of the first kind is Ka, and the amount of spin momentum due to a squirming velocity b of the second kind is kb; and the factor k[1] is always less than the factor K when the cat's body is curved.

Now suppose the falling cat to exert the muscular action necessary to produce and maintain a squirming velocity b; then the cat's body will simultaneously be set spinning in the first mode at spin velocity a such that

$$Ka + kb = 0$$

or

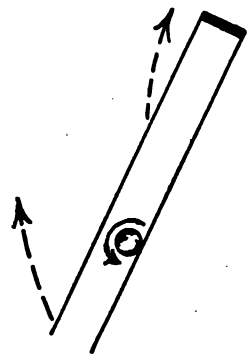
$$b = -(K/k)a,$$

because no spin momentum can be produced by forces inside the cat. Therefore a and b are opposite in sign and b is greater than a. Suppose, for example that b is twice as great as a; then while the cat squirms one complete revolution ($bt = 360°$) his bent form will rotate backwards through half a revolution ($at = 180°$), and the cat will be in the position shown in sketch No. 2, because each part of his body will have rotated through the angle $360° - 180°$ which is $180°$.

W. S. Franklin

HOW TO THROW A CURVED BALL

To the Editor of Science: I have tried a great variety of devices for throwing a curved ball for class-room demonstration, but with only moderate success, and I have tried in vain the method suggested by Professor J. J.



Thomson for causing a rubber balloon to travel in a sharply curved path. A year ago, Professor J. H. Wily suggested a method which is extremely satisfactory, as follows:

[1] This factor is not a moment of inertia in the usual sense of that term; but it is expressible in terms of the same unit.

A light ball of pith or cork or a ping-pong ball covered with varnish and rolled in fine sawdust is placed in a round pasteboard mailing tube and thrown by a quick motion of the tube as indicated in the accompanying sketch. The ball rolls along one side of the tube and is spinning rapidly when it leaves the end of the tube. The result is that the ball curves sharply upwards as it flies through the air, in some cases describing the cusped curve which is mentioned by Professor J. J. Thomson.

W. S. FRANKLIN

SEED DISTRIBUTION BY SURFACE TENSION

IN response to Mr. Becker's suggestion in SCIENCE, November 17, I may record what I have been accustomed to state in public concerning the distribution of seeds of water lilies (*Nymphæa* (L.) Sm.). Indeed, I was surprised to find that the observation had not already been published.

The fruits of *Nymphæas* mature under water, and burst irregularly, discharging the seeds a few inches or feet below the water surface. But the seeds rise at once and float by reason of a buoyant aril. The aril forms a kind of double-walled sac, open at one end, and enclosing the seed. It is mucilaginous in character and carries little bubbles in and upon it. I have often watched a mass of such seeds of *N. odorata, N. cærulea* or *N. lotus* upon a water surface. They separate from one another spontaneously and distribute themselves over the tank or pond in all directions, even though both water and atmosphere be perfectly still. It is wonderful how they steer about among floating leaves, and travel to the confines of their basin. Each one seems to repel all others. I have always believed this was due to surface tension or diffusion effects, but have never undertaken to prove the point or to determine the substances causing it. After some hours, the aril splits, the pieces curl up, and the heavy seed is released and sinks to the bottom of the pond.

HENRY S. CONARD

GRINNELL COLLEGE,
GRINNELL, IOWA,
November 20, 1911

MODELS OF VORTICELLA AND CYCLOPS

TO THE EDITOR OF SCIENCE: The Department of Animal Biology of the University of Minnesota recently received a model of a small colony of *Vorticella* and a model of *Cyclops* that deserve public notice.

These models are advertised in reputable catalogs and the stands bear printed labels that announce:

Awarded Gold Medal, Franco-British Exhibition, 1908

Biological Models. Made by Smedley, London, S. E.
Sole Agents, Gallenkamp & Co., 19 and 21 Sun St., Finsbury Square, London, E. C.

The models are made of a soft paraffin and are, without qualification, the poorest models that I have ever known to be advertised and for sale. They are absolutely devoid of any scientific value and are grossly untrue to even the most evident structural features. The appendages of the *Cyclops* (sp.?) are uniramous and no attempt has been made to indicate the relative lengths of the joints. Even the number of joints differs in the members of a pair. There is no attempt to represent the vestibule or "disk" of the *Vorticella* and the cilia are represented by feathers pressed into the paraffin. The paraffin is very slovenly put over wires and everything about the models indicates very crude workmanship and lack of knowledge. And such things are awarded gold medals!

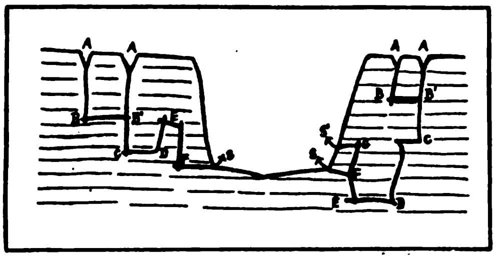
This is submitted for the protection of those disposed to use models in the class room and the laboratory.

HENRY F. NACHTRIEB

SIPHON SPRINGS AND SINK HOLES

Siphon Springs.—Intermittent springs as the result of the combination of a reservoir and siphon have long been favorite illustrations in the standard text-books of physics to show the practical application of the siphon. The familiar figure shows a small hill with a large cavern discharging its water by means of a siphon. Such a cavern emptying into a valley in this way must be extremely rare in

nature, if it ever occurs, and physiographers have done well (and physicists would do well) to omit it from their text-books. But in a modified form the siphon is probably occasionally operative. A figure which, although imperfect, is more in accord with the structure of limestone strata and the effect of solution upon them is given by de Martonne ("Traite de Geographie Physique," 1909, p. 347, fig.



147*A*). In this case (Fig. 1) the joints of the rock are shown to be widened by solution in such a manner as to make a siphon spring (*s*) possible. On the left a normal siphon is shown in which the spring does not flow until the reservoir *ABCD* is filled to *B*, that is, until the water begins to flow through the long arm *EF* of the siphon. On the right of the valley is an inverted siphon. It is perhaps unnecessary to state that although intermittent springs are the commonest of all springs the intermittent character seldom depends upon the presence of a siphon.

Sink Holes.—Sink or swallow holes are formed in one of two ways: (1) by the falling in of the roof of a cavern and (2) by the solution and erosion of the rock along joint or fault planes, the latter being by far the commoner origin. American writers of text-books of geology and physiography usually give but one explanation of the origin of these features and that the first and most unusual. Only two authors, as far as the writer is aware, give both. The popularity of the first explanation is probably due to the fact that the word "sink" implies a sinking in of the surface as well as the disappearance of the water by pouring into a funnel. The suggestion is offered that the older (?) term "swallow" hole be used, since it carries with it only the thought of the disappearance of the water in a throat or funnel.

HERDMAN F. CLELAND

WILLIAMSTOWN, MASS.,
November 3, 1911

THE RÔLE OF SALTS IN THE PRESERVATION OF LIFE

IN my address on "The Rôle of Salts in the Preservation of Life," published in No. 381 of SCIENCE, I made the following statement "Several authors, Lillie, McClendon and Lyon, have suggested that the fertilized egg is more permeable to salts than the unfertilized egg." Mr. R. Lillie calls my attention to the fact that he never made this suggestion. I feel it my duty not only to express my regrets for my oversight but to add that if my paper had dealt fully with the literature of the subject Mr. Lillie's ingenious experiments and original ideas should have occupied a prominent place in it, as those who are familiar with the subject will fully realize.

JACQUES LOEB

SCIENTIFIC BOOKS

Observations and Investigations made at the Blue Hill Observatory, Massachusetts, U. S. A., in the Years 1906, 1907 and 1908, under the Direction of A. LAWRENCE ROTCH. Annals of the Astronomical Observatory of Harvard College. Vol. LXVIII., Part II., 4to. Cambridge, Mass. 1911. Pp. 99–229, Figs. 15.

The work of the Blue Hill Observatory needs no introduction to the readers of SCIENCE. The progress of that unique institution, so important for American meteorology, has been faithfully recorded in the columns of this journal ever since the foundation of the observatory in 1884. Meteorologists have long since learned that the Blue Hill volumes of the *Annals of the Harvard College Observatory* are sure to contain results worthy of careful note and study.

Volume LXVIII., Part II., of these *Annals* contains the observations made twice daily in 1906–08; the usual summaries; results from the kite meteorograph and simultaneous records at the ground 1906–08; data obtained by means of *ballons-sondes* at Pittsfield, Mass., in 1908; supplementary data for a manned

balloon ascension from North Adams, Mass., July 29, 1908, and three memoirs. The first of these memoirs is by H. H. Clayton, on "A Study of Clouds with Data from Kites." Mr. Clayton has devoted himself so closely, for years, to the study of clouds and of kite data that this subject may in a very real sense be called peculiarly his own. The investigation is a very interesting one to all who have made any observations of clouds, and throws much light on many hitherto obscure points in cloud formation. In fact, it is one of the most suggestive discussions of the methods of cloud formation which has been published. The data used included all the measurements obtained up to January, 1909. A series of simple diagrams makes clear each step in the discussion. Cumulus clouds are found to be obviously caused by condensation in bodies of ascending air. Alto-stratus, alto-cumulus and cirro-stratus are probably formed in a stratum of air which is rising at a slight angle to the earth's surface. Strato-cumulus, on the other hand, is formed by a combination of local ascending currents and an ascending sheet of cloud. All clouds are found to be closely connected with inverted temperature gradients, the top of the cloud being usually in the coldest air immediately beneath the inverted gradient of temperature, and the height at which cloud formation can take place in the lower air being determined by the height above sea-level of the lowest inverted temperature gradient. The height above sea-level of the lowest inverted gradient of temperature and the complement of the dew-point determine whether days shall be cloudless or partly cloudy. There is thus a possibility of making practical use of the temperature and humidity observations obtained in the free air by means of kites and balloons for predicting the probable formation of various clouds, and therefore the probable weather that will follow. Mr. Clayton has left the staff of the Blue Hill Observatory, with which he was connected for nearly 23 years. His work there is well known to meteorologists the world over. His present study of clouds is perhaps the last memoir by him which will appear in the *Annals of the Harvard College Observatory*. It seems to us singularly appropriate that this particular study should have to do with kites and clouds, two lines of investigation which Mr. Clayton has done so much to further, and in which he has so unusually distinguished himself.

There are two further discussions, by Andrew H. Palmer, who has recently joined the staff of the observatory as research assistant, after leaving the graduate school of Harvard University. The first of these, on "Wind Velocity and Direction in the Free Air," deals with a subject concerning which the Blue Hill observations are able to supply valuable original data. There were used in this study the data obtained during 234 kite flights, made in 1897–1908; the cloud observations of 1890–91 and of 1896–97, and the *ballons-sondes* data from St. Louis, 1904–07. The principal results are as follows: (1) the general increase in velocity with height; (2) the rare occurrence of gusts of wind above low heights; (3) the frequent clockwise and occasional counter-clockwise changes of direction with height; (4) the shallow character of easterly winds; (5) the relative frequency of ascending currents as compared with those descending. It is easily seen that such results as these are of immediate practical importance in connection with aviation. Indeed, it is significant that both Mr. Clayton's study of clouds above referred to, and this one of Mr. Palmer's have such distinctly practical bearings.

A second paper by Mr. Palmer concerns "Pressure Oscillations of Short Wave-length." It appears that the pressure oscillations of short wave-length at Blue Hill are of two types, (1) those of 1–3 mm. amplitude, recurring irregularly over a period of several hours, and (2) those consisting of a single wave of 2–3 mm. amplitude occurring with certain thunderstorms. The former are due to the undulations set up at the horizontal boundary between two air strata of which the upper is the lighter, and in which the rate or direction of movement of one differs from that of the other. Type (2) seems to be

caused by the convectional currents in the agitated air mass of a thunderstorm. Comparatively little attention has thus far been paid to these short wave-length pressure oscillations, and Mr. Palmer has extended our knowledge of them by his examination of the Blue Hill records.

To have built and equipped, and to have maintained for more than 25 years, an observatory such as that on Blue Hill, which has done so much real pioneer work of the highest importance—surely this is a splendid contribution to science. To Professor A. Lawrence Rotch American meteorology, indeed meteorology everywhere, owes a debt which is year by year becoming greater.

R. DEC. WARD

HARVARD UNIVERSITY

Rock Minerals: Their Chemical and Physical Characters and their Determination in Thin Section. By JOSEPH P. IDDINGS. Second edition, revised and enlarged. New York, John Wiley & Sons; London, Chapman & Hall, Limited. 1911. Pp. 617. Cloth. $5.00.

That a second edition of Professor Iddings's work has so soon been called for speaks well for the growth of American petrography, while the constant tendency manifested toward a greater degree of refinement in methods speaks well for its future growth.

The present edition, so far as its plan is concerned, is practically identical with the first, the important difference being the addition of such new material as brings the work down to date. Upwards of 80 minerals are described not included in the first edition; "chiefly those occurring in pegmatites and segregated ores representing extremes of magmatic differentiation." Fifty-two figures are added in the text, and 67 pages of descriptive matter: a birefringence diagram is also added. Incidental to this diagram and the colored plate indicating the interference colors and birefringence of the various minerals it may well be asked if students entering upon the study of micro-petrography are ever tested for color blindness. It has often seemed to the reviewer that sundry imperfect (rather than erroneous) descriptions which have been published might be due to an inability on the part of the worker to distinguish the various colors, or at least to distinguish between their relative values.

The book, as in the previous edition, is divided into two parts, Part First, Chapter 1, being given up to a description of chemical principles and characters, and is identical with the edition of 1906. Chapter 2, dealing with the physical principles and characters, is also identical with the 1906 edition, and leaves nothing to be desired in its method of presentation. Chapter 3, on the optical properties, deals with what is perhaps the most difficult branch of the science for the student to master, and is naturally the most difficult to handle in a manner satisfactory to both worker and student. It demands the knowledge and the experience of the advanced worker and yet the teaching capacity of one who has not so far outgrown his student days as to be unable to appreciate the necessity of carefully detailed presentation. With the advanced student this chapter leaves little or nothing to be desired. As, with the exception of a page and a half on pleochroic halos, it is identical with the previous edition, nothing more need be said here regarding it.

Part 2 deals with the description of the various rock minerals taken up in the order of their chemical composition; alteration; crystallographic characters; optical properties; modes of occurrence; resemblances to other minerals, and laboratory production. It is to this portion of the book that the worker, however advanced, must have constant reference.

Professor Iddings is recognized the world over as an authority in all matters relating to petrography, and words commendatory are superfluous. The work is simply indispensable to all petrographers. The method of presentation is, however, naturally open to discussion. To the reviewer it would seem that for actual use and for purposes of ready reference more discrimination might well have been shown between minerals prominent as rock constituents and those rare: between

tests that may be applied to determine in the easiest and quickest way what a mineral actually is, and others which, though they may be of equal scientific interest, are unimportant or inapplicable. In its detail the work is monographic and if this is what the author had in mind there is naturally nothing more to be said. Criticisms along these lines are often unfair, being based upon what a reviewer thinks he has a right to expect rather than what the author intends. Whatever may be one's views on these subjects there is always the comforting reflection that the information given is as accurate as the stage of the science will permit.

The make-up of the book is the same as that of the first edition. The paper and binding are good, the type clear, and the illustrations excellent. Petrographers are to be congratulated that so able an authority has found time to put the knowledge gained by many years of study and experience into a form available for students the world over.

GEO. P. MERRILL

The British Nudibranchiate Mollusca. By ALDER and HANCOCK; Supplement by SIR CHARLES ELIOT. London, Ray Society (Dulau & Co.) 1910. 4to. Pp. 198. 8 plates.

Of works on this attractive group of mollusca, that of Alder and Hancock is *par excellence,* the classic, not only on account of its exquisitely beautiful and accurate plates, but from its monographic character and correct anatomical details. Among the posthumous papers left by the two authors were notes and drawings preliminary to a supplement to the original work.

To forty-two of these drawings Sir Charles Eliot has added twenty-three new ones and supplied a text, the whole being sent out by the Ray Society with suggestions for the completion of imperfect copies of the old work possessed by individuals interested in the subject. The form is that of the original monograph and the quality of the plates fully equal to that of the first issue.

But the author has not been satisfied with the preparation of a merely descriptive and corrective supplement. He has prefixed to the purely systematic portion chapters on variation and distribution, bionomics, embryology and larval stages, general classification of the group and an exhaustive discussion of the affinities and relationships of the animals concerned. These chapters not merely illuminate the subject but are from a merely literary standpoint presented in a form so clear and interesting as to be readable with pleasure by one having only a general knowledge of the mollusca. Such contributions to zoology are likely to invite study of the animals treated, and it is to be wished that works of this quality were more common.

WM. H. DALL

Duc d'Orleans, Campagne arctique de 1907. Par CHARLES BULENS. Bruxelles. 1910–11. *Etude lithologique,* par J. THOULET; *Echinodermes,* par JAMES A. GRIEG; *Mollusques et Brachiopodes,* par PHILIPPE DAUTZENBERG et HENRI FISCHER; *Microplankton des Mers de Barents et de Kara,* par le DR. ALPH. MEUNIER; *Faune des Mousses: Tardigrades,* par FERD. RICHTER; *Journal de Bord, et Physique du Globe,* par A. DE GERLACHE, etc.; *Appendice, Sondages de 1909,* par A. DE GERLACHE; planches et cartes.

The steamer *Belgica,* well known for her explorations in the Antarctic seas, has been engaged in Arctic exploration of late years, under the auspices of the Duke of Orleans and commanded by Commandant A. de Gerlache de Goméry. In 1907 the expedition left the northern coast of Norway at Hammerfest and Vardö, crossed the Murman Sea, circumnavigated the southern island of Novaia Zemlia, skirted the west coast of the northern island, penetrated to about latitude 78° in the Polar Sea, taking numerous soundings, before returning to Norway. In 1909 hydrographic explorations and soundings were made in the Greenland seas. By the munificence of the patron of the expedition the scientific results of the work are appearing in a series of finely illustrated and beautifully printed quartos. A summary of the titles of those which have

reached us appears in the heading of this article, the parts enumerated comprising 578 pages, 7 charts and 50 plates. Of this the larger part is comprised in a monograph of the Microplankton which takes up 355 pages and an Atlas of 37 plates. Lists of the birds and mammals observed are given in the "Journal." The mosses were extensively collected and contained an extensive fauna of minute invertebrates, of which the Tardigrades are described by Dr. Richter, about 30 species were obtained, of which five proved to be new. A minute copepod crustacean, *Moraria muscicola* Richters, which has adapted itself to a terrestrial habitat, was among the other animals found in the moss. The dredgings produced thirty-eight species of mollusks and two brachiopods, all well-known arctic forms. The Echinoderms included twenty-five species, a Crinoid, nine Ophiurans, eleven starfish, an echinus and three Holothurians, none of which proved new, which is not astonishing, since so many exploring expeditions have visited this region. The specimens of bottom obtained conformed in general to the character of soundings previously made in the Polar seas. The specimens studied are rich in garnet, pyroxenes and basaltic magmas, but showed no meteoric particles and were poor in magnetite. More than seventy soundings were made, of which nineteen were carefully analyzed. In the matter of terrestrial physics meteorology is discussed by Commandant de Gerlache, magnetism by A. Nippoldt and atmospheric electricity by G. Ludeling. The charts are from the latest researches published by the Russian Admiralty.

Altogether the present contribution adds a worthy member to the long list of publications on the ever interesting problems of the Arctic region.

Wm. H. Dall

Modern Geography. By Marion I. Newbigin. New York, Henry Holt and Company. 1911. Pp. 256.

Newbigin's "Modern Geography" is Volume 7 of the new Home University Library of Modern Knowledge, established by Williams and Norgate of London. It is a popular volume, aiming to summarize in two hundred and fifty pages the content of geography as now understood. Four chapters are devoted to the history of geography since the doctrine of evolution has revolutionized modern thought, to the development of surface forms and to climate and weather. Four chapters are devoted to the geography of plants and animals and the Races of Europe. The final chapter considers the Distribution of Minerals and the Localization of Industries and Towns.

The chapters are necessarily brief and in no case is it possible for the author to consider any topic in a really satisfactory manner; and yet the new ideas are outlined in simple, untechnical language, and with sufficient fullness to give the gist of modern thought, in every case. The reader will not, as is so frequently the case in volumes of similar scope, gain the impression that all has been said that might be said on any subject. He will, on the contrary, be naturally and easily led far enough into the subject to become interested in it and desire to learn more about it. A carefully selected list of references given in the appendix presents the reader with the logical next step in his advancement. Throughout the volume the author writes with a real geographic instinct and constantly inserts examples of the influences of physical conditions on life distribution and relations. In this way geography is shown to be a subject not merely of broad generalizations, but of real significance in understanding some of the common things of every-day life. Except in the chapter devoted to Plant Geography, where the author considers the plant formations of Eurasia and North America, but little attention is given to American conditions, and few illustrations of geographic relations are taken from the rich offering of our own continent.

Though the volume is thus European in tone, it is not by any means without value for readers in this country. It is a suggestive volume, interestingly written, that should appeal to the general reader, and offers many suggestions to the geographer, though he may

feel dissatisfied that it is not more complete in scope.

RICHARD E. DODGE

TEACHERS COLLEGE,
COLUMBIA UNIVERSITY

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

THE American Association for the Advancement of Science and the national scientific societies named below will meet at Washington, D. C., during convocation week, beginning on December 27, 1911.

American Association for the Advancement of Science.—President, Professor Charles E. Bessey, University of Nebraska; retiring president, Professor A. A. Michelson, University of Chicago; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.

Section A—Mathematics and Astronomy.—Vice-president, Professor Edwin B. Frost, Yerkes Observatory; secretary, Professor George A. Miller, University of Illinois, Urbana, Ill.

Section B—Physics.—Vice-president, Professor Robert A. Millikan, University of Chicago; secretary, Professor A. D. Cole, Ohio State University, Columbus, Ohio.

Section C—Chemistry.—Vice-president, Frank K. Cameron, U. S. Department of Agriculture; secretary, Professor C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D—Mechanical Science and Engineering.—Vice-president, President Chas. S. Howe, Case School of Applied Science; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E—Geology and Geography.—Vice-president, Professor Bohumil Shimek, State University of Iowa; secretary, Dr. F. P. Gulliver, Norwich, Conn.

Section F—Zoology.—Vice-president, Professor Henry F. Nachtrieb, University of Michigan; secretary, Professor Maurice A. Bigelow, Teachers College, Columbia University, New York City.

Section G—Botany.—Vice-president, Professor Frederick C. Newcombe, University of Michigan; secretary, Professor Henry G. Cowles, University of Chicago, Chicago, Ill.

Section H—Anthropology and Psychology.—Vice-president, Professor George T. Ladd, Yale University; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor William T. Porter, Harvard Medical School; secretary, Professor George T. Kemp, 8 West 25th St., Baltimore, Md.

Section I—Social and Economic Science.—Vice-president, Professor J. Pease Norton, Yale University; secretary, Seymour C. Loomis, 69 Church St., New Haven, Conn.

Section L—Education.—Vice-president, Professor Edward L. Thorndike, Teachers College, Columbia University; secretary, Professor C. Riborg Mann, University of Chicago, Chicago, Ill.

The Astronomical and Astrophysical Society of America.—December 27–29. President, Professor E. C. Pickering, Harvard College Observatory; secretary, Professor W. J. Hussey, University of Michigan, Ann Arbor, Mich.

The American Federation of Teachers of the Mathematical and the Natural Sciences.—December 27–28. President, Professor C. R. Mann, University of Chicago; secretary, Eugene Randolph Smith, Polytechnic Preparatory School, Brooklyn, N. Y.

The American Chemical Society.—December 27–30. President, Professor Alexander Smith, Columbia University; secretary, Professor Charles L. Parsons, Durham, N. H.

The American Society of Biological Chemists.—(Baltimore and Washington.) December 27–29. President, Professor Lafayette B. Mendel, Yale University; secretary, Professor A. N. Richards, University of Pennsylvania, Philadelphia, Pa.

The Society of American Bacteriologists.—December 27–29. President, Professor F. P. Gorham, Brown University; secretary, Charles E. Marshall, East Lansing, Mich.

The American Physiological Society.—(Baltimore and Washington.) December 26–29. President, Dr. S. J. Meltzer, Rockefeller Institute for Medical Research, New York City; secretary, Professor A. J. Carlson, University of Chicago, Chicago, Ill.

The Geological Society of America.—December 27–29. President, Professor William Morris Davis, Harvard University; secretary, Dr. Edmund Otis Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—December 28–30. President, Professor Ralph S. Tarr, Cornell University; secretary, Professor Albert Perry Brigham, Hamilton, N. Y.

The Paleontological Society.—December 28–30.

President, Professor William B. Scott, Princeton University; secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

The Entomological Society of America.—December 26–27. President, Professor Herbert Osborn, Ohio State University; secretary, Professor Alexander D. MacGillivray, University of Illinois, Urbana, Ill.

The American Association of Economic Entomologists.—December 27–29. President, Professor F. L. Washburn, St. Anthony Park, Minn.; secretary, A. F. Burgess, Melrose Highlands, Mass.

The American Microscopical Society.—December 29. President, Dr. A. E. Hertzler, 402 Argyle Building, Kansas City, Mo.; secretary, T. W. Galloway, Decatur, Ill.

The Botanical Society of America.—December 26–29. President, Professor William G. Farlow, Harvard University; secretary, Dr. George T. Moore, Botanical Garden, St. Louis, Mo.

The Society for Horticultural Science.—December 29. President, Professor S. A. Beach, Ames, Ia.; secretary, C. P. Close, College Park, Md.

The American Phytopathological Society.—December 27–29. President, Professor A. D. Selby, Wooster, Ohio; secretary, Dr. C. L. Shear, Department of Agriculture, Washington, D. C.

The American Nature-Study Society.—December 27–28. President, Professor Benjamin M. Davis, Miami University; secretary, Dr. Elliot R. Downing, University of Chicago, Chicago, Ill.

The Sullivant Moss Society.—December 28. President, Dr. Alexander W. Evans, Yale University; secretary, Mrs. Annie Morrill Smith, 78 Orange Street, Brooklyn, N. Y.

The American Fern Society.—December 29. President, Dr. Philip Dowell, Port Richmond, N. Y.; secretary, L. S. Hopkins, Peabody High School, Pittsburgh, Pa.

The American Anthropological Association.—December 27–30. President, Dr. J. Walter Fewkes, Bureau of Ethnology; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-Lore Society.—December 28. President, Professor Henry M. Belden, University of Missouri, Columbia, Mo.; secretary, Dr. Charles Peabody, Peabody Museum, Cambridge, Mass.

The American Psychological Association.—December 27–29. President, Professor Carl E. Seashore, University of Iowa; secretary, W. Van Dyke Bingham, Dartmouth College, Hanover, N. H.

The Southern Society for Philosophy and Psychology.—December 28–29. President Dr. S. I. Franz, Government Hospital for the Insane, Washington, D. C.; secretary, Professor R. M. Ogden, University of Tennessee, Knoxville, Tenn.

The American Economic Association.—December 27–30. President, Professor Henry W. Farnam, Yale University; secretary, Professor T. N. Carver, Harvard University, Cambridge, Mass.

The American Statistical Association.—December 27–30. President, Frederick L. Hoffman, Newark, N. J.; secretary, Carroll W. Doten, 491 Boylston Street, Boston, Mass.

The American Sociological Society.—December 27–30. President, Professor Franklin H. Giddings, Columbia University; secretary, Professor A. A. Tenney, Columbia University, New York City.

The American Civic Alliance.—December 29. President, Dr. John Franklin Crowell, 44 Broad St., New York City; secretary, Dr. Gerald van Casteel, 80 Wall St., New York City.

The American Association for Labor Legislation.—December 28–30. President, Professor Henry R. Seager, Columbia University; secretary, Dr. John B. Andrews, Metropolitan Tower, New York City.

The American Home Economics Association.—December 27–30. President, Miss Isabel Bevier, University of Illinois; secretary, Benjamin R. Andrews, Teachers College, Columbia University, New York City.

PRINCETON, N. J.

The American Society of Naturalists.—December 28. President, Professor H. S. Jennings, The Johns Hopkins University; secretary, Professor Charles R. Stockard, Cornell Medical School, New York City.

The American Society of Zoologists.—December 27–29. President, Professor H. V. Wilson, University of North Carolina; secretary, Dr. Raymond Pearl, Maine Agricultural Experiment Station, Orono, Me.

The Association of American Anatomists.—December 27–29. President, Professor George A. Piersol, University of Pennsylvania; secretary, Professor G. Carl Huber, 1330 Hill Street, Ann Arbor, Mich.

NEW YORK CITY

The American Mathematical Society.—December 27–28. President, Professor H. B. Fine, Princeton University; secretary, Professor F. N. Cole, 501 West 116th Street, New York City.

SCIENCE

Friday, December 22, 1911

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

GRADUATE WORK IN MATHEMATICS IN UNIVERSITIES AND IN OTHER INSTITUTIONS OF LIKE GRADE IN THE UNITED STATES[1]

I. THE ESTABLISHMENT OF ADVANCED INSTRUCTION IN THE UNITED STATES

Forty years ago the bachelor's degree granted on the completion of a four years' course of a general character marked not merely the close of a young man's liberal education, but also, except in the case of some lawyers, ministers and physicians, the end of all academic instruction of any kind. In particular, apart from a few exceptional cases, no advanced instruction in mathematics was anywhere provided beyond the usually rather meager ingredients—hardly more than analytic geometry and a little calculus—of this college course, which consisted mainly of prescribed studies. As an external sign of this state of affairs we note that the master's degree, where it existed, was conferred for reasons having very little to do with study, while the doctor's degree was practically non-existent.[2] The desire for higher education in America, which had been felt for many years by some of the leading minds of the country, had been able so far to achieve only momentary and sporadic success.

[1] General report of the committee consisting of Professor Maxime Bôcher, Harvard University, Cambridge, Mass., *chairman;* Professor D. R. Curtiss, Northwestern University, Evanston, Ill.; Professor Percey F. Smith, Yale University, New Haven, Conn., and Professor E. B. Van Vleck, The University of Wisconsin, Madison, Wis. The report is Bulletin No. 6 (1911) of the United States Bureau of Education.

[2] Except at Yale University, where the degree of doctor of philosophy was established in 1860.

The most notable example of such a momentary success, so far as the study of mathematics is concerned, is to be found at Harvard during the fifties and early sixties, where, under the guidance of Benjamin Peirce, a band of young men devoted themselves successfully to the pursuit of higher mathematics.[3] A few of these have since attained world-wide fame, while others were influential in introducing advanced mathematical instruction into the United States twenty or thirty years later. Peirce's success in collecting at this time a fair number of competent students for graduate work seems to have been due primarily to the presence of the office of the American Nautical Almanac at Cambridge from 1849 to 1866, and, secondarily, to the founding in 1847 of the Lawrence Scientific School,[4] which, in those early years, possessed, under the leadership of Louis Agassiz, Jeffries Wyman, Asa Gray and others, some of the aspects of what is now known as a graduate school.

We notice, in passing, the contrast presented at this time, and for many years after, between the increasing supply of good astronomers in this country and the lack of men who, even by a stretch of the imagination, could be called mathematicians. It may fairly be said that the mathematical talent of the country was at this time diverted to astronomy.

Various circumstances united to bring a large measure of success in the establishment of graduate instruction in all fields, and in particular in mathematics, during the years 1870–1890. The great increase of wealth in the country brought with it endowments of many sorts which strengthened the older universities and established some important new seats of learning. Three things may be mentioned which, on this basis of material prosperity, did more than anything else to help forward the cause of graduate study in the critical period we are now considering.

1. *Study Abroad.*—For many years an occasional American had gone abroad to complete his studies. Thus B. A. Gould, a pupil of Benjamin Peirce and a graduate of the class of 1844 at Harvard, who later became eminent as an astronomer, studied with Gauss in Göttingen and took his doctor's degree there in 1848. Similarly J. Willard Gibbs after taking his doctor's degree at Yale in 1863 spent three years (1866–1869) in Paris, Berlin and Heidelberg, where he studied with Kirchhoff, Helmholtz, Weierstrass and others. A few more cases of a similar sort might be recorded, but it was not until the end of the seventies or the beginning of the eighties that the stream of mathematical students from America to Europe (generally to Germany) became a steady one. This tendency to go to Germany for the closing years of study contributed probably more than anything else to build up sound standards of productive scholarship and of graduate teaching, without which all attempts to establish advanced instruction in this country must have remained abortive. Its success was in part due to the establish-

[3] Peirce was tutor or professor of mathematics at Harvard from 1831 till his death in 1880, but, except during the period here considered, it was only in the last ten years of his life that, under the influence of an expanding elective system, he again began to have an appreciable number of advanced students.

[4] In the same year the department of philosophy and the arts was organized at Yale with the purpose of furnishing "resident graduates and others with the opportunity of devoting themselves to special branches of study," these branches embracing "theology, law, medicine and more particularly mathematical science and physical science and its applications." It was in this department that the doctor's degree was established in 1860, as noted above.

ment and the wise administration of traveling fellowships, first at Harvard and then, to a much less degree, elsewhere. We shall return to this important matter of study abroad in a later section.

2. *The Foundation of Johns Hopkins University.*—The magnificent bequest of Johns Hopkins of $3,500,000 for the foundation of a university in Baltimore, and his wisdom in leaving his board of trustees a free hand in the organization of the institution resulted in the adoption, on President Gilman's initiative, of a plan whereby the ordinary undergraduate instruction was relegated to a subordinate position from the very start, so that the new university stood before the American public as the standard bearer of the higher education. This was of inestimable benefit in strengthening the hands of those members of the faculties of the older universities who had been struggling to establish and develop graduate instruction at their own institutions. The presence of the eminent English mathematician, Sylvester, as professor of mathematics during the first seven years of the Johns Hopkins University had also a marked effect in stimulating interest in advanced mathematical studies in America, though it is easy to overestimate his direct influence, as he was a poor teacher with an imperfect knowledge of mathematical literature. He possessed, however, an extraordinary personality, and had in remarkable degree the gift of imparting enthusiasm, a quality of no small value in pioneer days such as these were with us.

3. *The Elective System.*—At the beginning of the period under consideration the lack of students qualified to undertake advanced work was most keenly felt and made any large success in the establishment of graduate instruction an impossibility. The adoption under the lead of President Eliot, first at Harvard and then to a greater or less extent throughout the country, of a far-reaching elective system in the four-years' undergraduate course furnished a possibility for the gradual extension of instruction in the special fields. Without entering on the question of the advantages and disadvantages of the elective system for the college itself, we may safely say that it provided a basis for advanced instruction without which any considerable development of such instruction, at least during the years of which we are now speaking, would hardly be conceivable.[5]

At the close of the period we are considering, when the idea of graduate instruction had already taken a firm hold on many of the stronger institutions of the country, the founding of Clark University exclusively for graduate study in mathematics, psychology, biology, physics and chemistry gave a further impetus to specialization in advanced work, and the opening of the University of Chicago in 1892 may almost be said to mark an epoch in the development of graduate instruction in the west and middle west; for, though that university had from the start an undergraduate department, it stood out, through the character of its faculty and the emphasis laid on research work, as a strong exponent of the graduate idea.

While in these universities, as well as at

[5] Cf., however, the closing remarks of section II. What we desire to emphasize here is that an elective system so arranged as to allow some specialization in individual departments, not merely the choice between various *elementary* subjects, permitted a gradual development of more and more advanced instruction, the students being at first mainly undergraduates. *Such* a development could go on simultaneously at many places, while even a single attempt to duplicate the Johns Hopkins experiment would probably have quickly led to disastrous failure.

Johns Hopkins, advanced instruction was at once placed in a department by itself, in by far the larger number of institutions it developed very gradually within the old college, room being made for it by the elective system; and it was only slowly, even in the larger institutions, that small groups of graduate students began to collect. The somewhat unorganized condition, which was then the rule, is still to be found in the weaker institutions of the country and also in some colleges which in their chosen field of undergraduate work are strong, but which voluntarily renounce any substantial development of graduate instruction. The great universities, however, have all, since the year 1890, developed well-organized graduate schools frequented by the graduates of their own and other colleges. It may be added, to avoid possible misconception, that the graduate schools which sprang full-fledged into existence and those which developed slowly from the old college no longer form two distinct classes. Some of the strongest graduate schools in the country are now to be found among the last-named institutions.

In contrast with such countries as France, Italy and, to a less extent, Germany, we note the complete lack of central control or organization in the United States. Many variations are hereby made possible which are, for a country like ours, almost a necessity; and competition, on the whole healthy, springs up between the different institutions.

In conclusion we note that of late years some technological schools (for instance the Massachusetts Institute of Technology) have undertaken a limited amount of graduate instruction in mathematics. As this instruction does not differ, except in the greater emphasis laid on applied mathematics, from that given at colleges and universities, and since the amount of such instruction at technological institutons is as yet very small in comparison to the whole amount of mathematical graduate instruction in the country, we have not thought it necessary to mention these technological schools specifically in what follows.

II. THE GRADUATE STUDENT OF MATHEMATICS AT THE PRESENT DAY

Owing to the great variety of standards for the bachelor's degree in the different colleges of the country, the students of a single graduate school enter it with very diverse preparation. This is, however, not so disturbing as might be expected, owing to the fact that at every university in which a graduate school exists there is a collegiate or undergraduate department whose instruction is freely open to the graduate student who is in need of it. We may then say that not all work done by graduate students is graduate work. On the other hand, the ambitious and capable senior in colleges allowing considerable freedom of election will frequently be doing work of a distinctly graduate character in the same classes with able graduates of colleges in good standing.

If we thus miss any sharp line of demarcation at the lower limit of the graduate school between graduates and undergraduates, we find a similar phenomenon at the upper limit where the graduate student often passes by almost imperceptible steps into the teacher. Indeed there are graduate schools, even among the better institutions of the country, the bulk of whose students are at the same time assistants or instructors. This, and the very high percentage of graduate students of mathematics the country over who are fel-

lowship and scholarship holders are features of American education which, it is to be hoped, will gradually pass away.[6] They are closely related to the presence in graduate schools of large numbers of students of mathematics who have reached an age when their students days should be over. It can not be too strongly urged on all who give young men advice or who are influential, by awarding scholarships or otherwise, in shaping their careers that it is only in his first youth (not at the age of thirty or thirty-five) that the foundation of real success can be laid by the student of mathematics.

A somewhat different class is formed by school teachers in active service who are at the same time enrolled as graduate students of mathematics, but at any moment take necessarily only a small amount of work. The ambition of these teachers to improve their professional equipment is most laudable. When, however, as is sometimes the case, they form a considerable proportion of the enrollment of a graduate school, they may be a source of weakness to that school in spite of their earnestness of purpose.

The period spent by a student in graduate study varies from one to three, or even more years; and the amount of migration from one university to another does not seem to be large, although the great majority of students attend a graduate school at a different university from that at which their undergraduate years were spent.

We note also that in graduate work coeducation is the almost universal rule, not only in the great state and other western institutions where coeducation forms an integral part of the scheme of education from top to bottom, but even in the most conservative institutions of the east, which do not admit women to their undergraduate departments. Apart from Princeton and the University of Virginia, where no women are admitted, it is only in women's colleges (Bryn Mawr, Vassar, etc.) and in some institutions for men which have held firmly to the undergraduate idea, so that the amount of graduate work is very limited, that one sex alone will be found.

A striking and significant fact is that nearly half of all graduate students of mathematics come from small colleges. This is probably due to the fact that in such colleges students always have the opportunity to study the elements of mathematics and often something beyond the elements, while the inducements for them to turn away into other fields are slight in comparison to those offered at larger institutions where a richer elective system prevails. The tendency so strong in our day and country to regard the man of action as being of nobler clay than the man of thought and ideas, reinforced by the much greater financial prizes open to the former, whether he be lawyer, business man or engineer, creates a situation where it is not easy to secure for mathematical study a due proportion of the strongest youth in our college communities.

III. THE ORGANIZATION OF ADVANCED MATHEMATICAL INSTRUCTION[7]

The purpose of mathematical instruction should be fourfold:

I. To impart knowledge.

II. To develop power and individual initiative.

III. To lead the student to express adequately and clearly what he knows.

[6] Nothing in any way resembling this free award of financial aid is found necessary to induce strong men to attend schools of law or engineering. Cf. the closing lines of this section.

[7] Cf. also the report of subcommittee 1.

IV. To awaken the love of knowledge and to impart scholarly ideals.

The first of these aims, without attention to which the other three can not be obtained, has led to the great development of the lecture system which we find in all graduate schools, and to the use of the textbook and treatise either in connection with these lecture courses or independently of them, and of the original memoir, the reading of which constitutes an art by no means easy to acquire, and which deserves special cultivation at the hands of the members of the teaching staff.

As means used under II. may be mentioned: First, the solution of problems by students either in connection with the lecture courses or in special seminars or proseminars, and secondly, the writing of theses which may or may not be connected with the doctor's degree. This last is also the chief means employed under III., although the quiz (cf. subcommittee 3, section IV.) is sometimes employed effectively for this purpose, and even the brief written problem is not without some value here.

Both II. and III, above should receive more attention than is now commonly given to them, while I. is at present adequately treated, except, perhaps in the relative weakness of applied as distinguished from pure mathematics.

The aim indicated under IV. depends for its attainment less on special methods of instruction and more on the personality of the instructor and his attitude towards science than do I., II. or III. To secure adequately the end in view, an instructor is needed who combines high *scientific* ideals with a commanding or sympathetic personality. Such men could do much to counteract the tendency noted in the closing lines of section II., but, on the other hand, it is precisely this tendency which makes them difficult to secure. Their influence on undergraduate instruction should be no less valuable than in the graduate school.

We must come back once more to the lecture courses which everywhere form the backbone of graduate mathematical instruction. Such a course usually extends either through the whole academic year, that is, from the end of September till early in June, or through the first or second half of this year.[8] The lectures, of somewhat less than an hour each, come usually three times (less frequently twice) a week. While much depends on the local traditions and the personality of the instructor, it may in a general way be said that these lectures have a far less formal character than is the case in European universities. Students will frequently interrupt the lecturer with a question, and short discussions between the instructor and one or more students will not infrequently take place, and at times the more formal quiz (cf. subcommittee 1, section VI., and subcommittee 3, section IV.) finds its place here. Some tact and firmness are occasionally necessary to prevent the loquacious or thick-headed student from monopolizing the time of the class, but on the whole this frequent contact during the lecture between teacher and student is an admirable feature of American higher education, and counteracts, to a certain extent, some evils which usually accompany the lecture system. It is made possible by the smallness of the classes, an audience of twenty-five in a graduate course in mathematics being distinctly unusual.

The range of subjects covered by the courses offered in each graduate school is

[8] Attention must also be called to work in the summer schools and summer quarters. Cf. subcommittee 1, section IV.

very great (cf. subcommittee 1, section V.). This is peculiarly the case in those institutions which have only recently begun a policy of expansion in their graduate work, where the first sign of such expansion often appears in an astounding increase in the number and range of courses offered, for only a small part of which there are students. Indeed, if students should present themselves, the capacity of the teaching force would be completely overtaxed. This is a state of affairs which no self-respecting institution should allow to continue, and there are signs that it is usually of only a temporary nature, since with a real strengthening of the mathematical department of such an institution this inflation tends to disappear. We hasten to add that the stronger institutions, and many smaller institutions with a due sense of proportion, offer admirable selections of courses commensurate with their capacity and the needs of their students, courses which at each institution usually vary considerably from year to year. Even in the weaker institutions where a call for advanced instruction is hardly apparent, it may often be wise to encourage instructors to offer a course of a not wholly elementary character, as it will frequently be found to act as a tonic and, by keeping them in touch with the scientific side of their subject, enable them to make their elementary work more vital.

It was mentioned in section II. that no sharp distinction between graduate and undergraduate work in mathematics can be made. Indeed it is hard to exclude entirely from graduate work anything above the first course in the calculus, now commonly taken in the second undergraduate year. The actual state of affairs is best expressed by regarding the group of courses just following this point, such as a second course in the calculus, the elements of determinants and of the theory of equations, projective geometry, a first course on differential equations, etc., as belonging both to graduate and to undergraduate instruction. From this latter point of view, however, these courses usually appeal only to the student of distinct mathematical ability and seriousness of purpose, whose presence in the course along with graduates does not very greatly affect the character of the course.

As the external signs of success for the graduate student we have the master's and the doctor's degrees. The first of these is commonly given for one year's graduate work done largely in one subject, such as mathematics or physics, and tested either by course examinations in which a higher standard is demanded than is accepted for undergraduates, or by a single examination covering the whole year's work. A thesis is also often required for the master's degree; but the work done on this thesis is not commonly of the nature of research work, and the degree is taken by considerable numbers of students most of whom never proceed further. This degree is given, and properly given, by a large number of institutions, many of which have only a very moderate strength in their graduate mathematical work. Under these conditions suggestions for a minimum standard for the degree are not out of place, and such suggestions will be found in the report of subcommittee 1, section VII.

The doctor's degree originally came to us from Germany, but has long been naturalized and is in all American institutions of good standing distinctly a research degree. In several of our stronger universities it has a standard at least as high as the best German standard. The requirements for the doctor's degree in universities which

have been given to any extent during the last ten years are tolerably uniform (cf. the report of subcommittee 2), but in this matter so much depends on the unwritten standards of individual professors or departments that there still remains a great difference in the ease with which the degree can be obtained at different institutions. It is for this reason that the suggestion which is sometimes made that it would be well to attempt to formulate definite standards for the doctor's degree, to which the universities of the country should conform, seems to be of slight practical value.

In school and college work America adopts in one respect a very different standpoint from France and Germany, and this has a certain indirect influence on graduate work. We refer here to the fact that in the last-named countries a pupil will not be allowed to proceed from class to class, and, particularly, will not be allowed to pass the great educational landmarks (for instance graduation from the gymnasium in Germany) without conforming to a very exacting standard which a considerable percentage of each class fails to attain. In America, on the other hand, the teacher who tries to impede seriously the progress of any but the unusually lazy or stupid soon makes himself impossible. This is not the place to discuss the respective merits of these two points of view in the secondary school or even in the college; but when we come to the graduate student of mathematics it seems clear that the American attitude must be modified, and, as a matter of fact, in all the stronger institutions of the country a much greater ability and earnestness of purpose is demanded for passing examinations and securing degrees in the graduate school than would be allowed to pass muster in undergraduate work. Nevertheless, it is to be hoped that something more will be accomplished in this direction, and that, in particular, candidates for the doctor's degree will be made to feel that success for them at an institution of good standing is not a mere matter of time and patience. It is the more important to insist on this, since, as has just been said, the whole current of secondary and college education runs in another channel.

IV. TEACHERS

We must be concerned with this subject for two different reasons, first, because the great majority of graduate students of mathematics ultimately become teachers in secondary schools, colleges or universities; and, secondly, because on the quality and efficiency of the teachers in the graduate school itself (professors, instructors, etc.) depends to such a large degree the quality of the school.

It is a favorable sign of the gradual elevation of the profession of secondary-school teacher that of late years many persons wishing to adopt this profession spend a year in study in a graduate school. It is true that this time is frequently not spent in the study of a single subject; but for the future teacher of mathematics (or of mathematics and some other subject) to have had a couple of graduate courses in mathematics, usually in the intermediate group, is a very substantial gain over the conditions of twenty years ago. It is to this class of students that the courses on the teaching of mathematics, which are now given at many colleges and universities, mainly appeal.

If we except this group who go into secondary-school teaching, and a second group who study mathematics as a tool for use in some other science, such as physics, it may be said with almost absolute pre-

cision that all other students of mathematics in graduate schools become instructors in mathematics in colleges or universities. The condition of twenty-five years ago, where college instructors in mathematics were taken from among the freshly graduated students of a college (usually the same college where they were to teach), has now become the exception instead of the rule; and where it still occurs, the appointment is usually a temporary one, both the instructor and the college expecting that, after a year or two of teaching, further graduate study will follow. The gain involved in this changed state of affairs, both in breadth of view and in real mastery of the subject, the teaching of which is to be the young man's life work, is so obvious as to require no further comment here. If the student can furthermore be given some comprehension of the fact that the science of mathematics is a living and growing one through contact with other students or instructors who are themselves contributing to this growth, and still more if he himself can take some part in the development of mathematical knowledge, his outlook on mathematics in particular and intellectual life in general will have been so broadened that he can hardly fail to become a better member of a college faculty than would otherwise have been the case.

After all this has been said, we must, however, admit that this question has also another side less pleasant to contemplate. What passes for original research, in this country more even than abroad, is often hardly a real contribution to mathematical progress at all, but merely a grinding out of results, which if they have only never been published before may be as unimportant and unattractive as you please; they form an "original contribution." One is tempted to answer, Yes, in the same sense as the brass button in the contribution box. We may feel certain that in the long run this will be the character of the research work done by students who have no real capacity or inclination for original work, but who are pushed into it by the increasing demand, on the part of certain heads of departments, for the doctor's degree as a necessary preliminary to college teaching. The pressure thus produced will surely, if persisted in, bring forth an increasing yearly crop of doctors—success can be obtained by almost any one with a fair mathematical capacity and with sufficient industry and patience, either by going abroad or by going to one of the weaker American institutions with an ambition for giving the doctor's degree. It is doubtful if the time will ever come, certainly it will not come for a great many years, when all the members of the teaching staffs of the large universities of the country, and the colleges of like rank, can be men with a real capacity for original investigation; the number of all such men in the country falls far short of (one might almost say that it is of a different order of magnitude from) the number of places to be filled.

The pseudo doctor, to whom reference was made above, is often narrowed rather than broadened by the bit of investigation which he has been set to do, and becomes thereby less effective as a teacher, investigation for him becoming a fetich for which he forgets all other ideals. Or, on the other hand, he may let all thought of original work drop out of his mind when once he has secured his degree. In either case the letters he places after his name ought not to go very far in recommending him for teaching positions. A broad and deep mathematical training should surely be demanded by all the institutions of the country which claim collegiate rank as a prerequisite for a permanent appointment on

their teaching staff. They will naturally demand also some ability as a teacher. If in addition they can secure an investigator of a genuine sort, even though his caliber be slight, they should usually regard themselves as fortunate, though a few of the strongest institutions can and should set themselves a much higher standard. On the other hand, our stronger graduate schools should continue, as they are now doing, to encourage every capable student to try his hand at some piece of original investigation, but they should not hesitate, after a fair trial, to tell him, if that turns out to be the case, that he is not fitted for that kind of work.

No specific training for the profession of college or university instructor is commonly given in graduate schools apart from the training in mathematics (cf. subcommittee 3, section V.). The statement made in section III. of the present report that the training in clear and adequate exposition which is given to graduate students of mathematics is frequently insufficient is of peculiar importance in relation to the future teacher. While it is probably not desirable to attempt to train the future college or university instructor in the art of teaching, the question whether more can not be done to lead graduate students of mathematics to express their ideas well both in spoken and in written form is worthy of serious consideration.

Let us turn now from the graduate students, who are to become college instructors, to the actual instructors and professors of mathematics in our colleges and universities. If we compare conditions at the present day with those existing twenty years ago, a very great increase in the standard of mathematical knowledge on the part of the teaching staff is evident. That the improvement here has not been even greater is due in large measure to the fact that the supply of well-trained graduate students falls far short of the demand. Weak appointments are also made from time to time, owing to ignorance on the part of trustees or heads of departments of what really constitutes a mathematician, to the pernicious view that administrative ability may be allowed to take the place of mathematical ability, or to other like causes. Flagrant cases of this kind occasionally occur which make one blush for the good name of American universities, but such cases are now merely sporadic and one gains comfort by contemplating conditions in Germany only a hundred years ago. What is needed here, as in so many other places in American life, is a strengthening of *intelligent* idealism (we have more than enough misdirected idealism amongst us) based upon knowledge, and there seems every reason to hope that the great development of mathematics in this country during the last twenty years, evident chiefly in the growth and activity of the American Mathematical Society, will in an ever-increasing degree supply the intelligent and influential public opinion here needed. The shortage, above mentioned, in the supply of instructors in mathematics forms the most serious aspect of the situation.

For various further points: The excessive burdening of young instructors with drudgery, which still often occurs; inadequate salaries; the burdening of professors with administrative work; we refer to the report of subcommittee 3.

V. STUDY BY AMERICANS ABROAD

No account of higher mathematical education in America would be complete without a reference to the part played by the study of Americans abroad. What an im-

portant factor this was in introducing advanced mathematical instruction and research into America has already been mentioned in section I. In the early days the possibilities for advanced mathematical study in this country were very limited, so that it was natural that students able to do so should go abroad where they could find this opportunity in large measure. At the present day it may safely be said that at several of the stronger American graduate schools most American students find mathematical opportunities better suited to their needs than are to be found at any place abroad. Nevertheless, students still go abroad in apparently undiminished numbers to study mathematics,[9] and their decision to do this is frequently a wise one. Let us inquire how this can be the case.

There come first considerations of a nonmathematical character. It is desirable for every one to become acquainted at first hand with other countries than his own, and this is doubly true for an American, for whom a period of residence in European countries is invaluable. It is true that the student often seems to have brought back from a year or two of residence abroad only a strengthening of his earlier national prejudices, since the mote in the neighbor's eye is so very easy to discern;[10] but if he is worth his salt, he brings with him a fund of impressions and experiences which, as time goes on, greatly enrich his life. For this reason alone study abroad is to be recommended even at some mathematical sacrifice. A second consideration is that the cost of living in Germany, to which country the great majority of students going abroad have always resorted, even after the great increase of the last few years, is still lower than in America, and in particular, the tuition fees are much less than in many of the larger American institutions, especially of the east. These facts largely counterbalance the expense of the trip across the ocean. Finally, it is to be remembered that a year or two of mathematical study in Germany, France or Italy gives the student a reading and speaking knowledge of one of the great languages of modern thought, besides his own native English, such as can hardly be acquired in any other way.

When we come to mathematical considerations, the first question we must ask is whether getting a degree or learning mathematics is the prime object of the student going abroad. It is the former which,

[9] It would be a matter of considerable interest to have statistics on the number of American students who go abroad each year to study mathematics and the length of time they stay. Such statistics would seem to be very difficult if not impossible to secure. As to the proportion of instructors of graduate courses in mathematics who have spent at least one year abroad, see the report of subcommittee 1, section III. Far less important is the question of the number of doctors' degrees conferred on Americans abroad. Such information might be secured. We content ourselves with giving two such items, for which we are indebted to Dr. Dunham Jackson:

At Göttingen in the years 1889–1909, inclusive, twenty-two Americans received the degree in mathematics, while no degrees in mathematics had been conferred on Americans during the four previous years.

At Leipzig in the years 1885–1902, inclusive, eight Americans received the degree in mathematics, while after this time Americans seem to have ceased taking the degree in mathematics there.

At present from two to four Americans take their degree in mathematics in Germany each year, as against an average of sixteen or seventeen in the United States.

[10] There are also cases in which he takes so kindly to foreign conditions as to become out of touch with America. It is, however, rare that this state of affairs should survive his return more than a few months.

owing to circumstances mentioned in section IV., is too often uppermost in his mind. A student of this category had much better go abroad for his degree than to a second-rate American institution. Of course some care must be exercised by him in the choice of his university, or he must have good fortune in writing a thesis whose weak points are not evident on a superficial examination, but his task is, on the whole, not a difficult one, and he gets at least the advantage of a period of foreign residence.

For another class of men foreign study may be recommended without qualification, namely, for able students who have already had a substantial training in one of the better American graduate schools, or who have even taken the doctor's degree at such a school. Such men will naturally go either to one of the great mathematical centers like Paris or Göttingen, where they will have the opportunity to hear lectures by several of the leading mathematicians of the day, and, perhaps, to see some of them occasionally outside of the lecture room; or they will select some mathematician of eminence in a particular field with whom they may hope to gain direct personal contact, and go to the university where he happens to be. Thus of late years a small but steady stream of American students has gone to Italy.

To the students just considered, and to some extent to their weaker comrades mentioned above, the period of residence at a great European mathematical center or of contact with an eminent mathematician at a less important European institution brings with it a realization of what high scientific ideals in mathematics are, and to what an extent they prevail abroad. Such ideals prevail also, it is true, at the strongest American institutions; but it is hard for the young American to appreciate their great diffusion in a ripened civilization until he has experienced it by personal contact.

ADDRESS AT THE UNVEILING OF THE BUST OF WOLCOTT GIBBS IN RUMFORD HALL, CHEMISTS' CLUB, NOVEMBER 25, 1911

Because of the place of his birth and that where he was educated; because of the profession he chose and which he so highly adorned; because during the greater part of his mature life he applied his splendid talents and broad attainments to the realization of the hopes of the founder of the Royal Institution in his bequests to Harvard College and to the American Academy of Arts and Sciences; and because he was an academician and a club man, it is eminently fitting that the bust of Wolcott Gibbs should be unveiled in the Rumford Hall of the Chemists' Club of the City of New York.

For on February 21, 1822, he was born in this city of New York; in 1841 he received his baccalaureate degree from Columbia College of this city; in 1845 he received the degree of M.D. from the College of Physicians and Surgeons of this city; he chose chemistry as his profession; he was Rumford Professor of Harvard College and Harvard University for forty-five years and a member of the Rumford Committee of the American Academy of Arts and Sciences for thirty years; he was founder, member and president of the National Academy of Sciences; he suggested and organized the Union League Club of New York and he promoted and supported other social organizations.

His education was, however, much broader and more comprehensive than that comprised in his satisfaction of the requirements for the degrees awarded him at Columbia College and the College of Physicians and Surgeons, for in the interim between his graduation from the first named institution and his entrance on the second he served as laboratory assistant to Dr. Robert Hare, professor of chemistry in the University of Pennsylvania, then the most

eminent chemist America had produced and to-day revered for his splendid contributions to science. On his graduation from the College of Physicians and Surgeons, Gibbs went to Europe, where, until 1848, he continued his studies under the direction of the eminent chemists, Rammelsberg, Heinrich Rose, Liebig, Laurent, Dumas and Regnault, whose names are each inscribed upon the honor roll of those to whom the chemistry of to-day owes its place among the sciences.

Broadened by travel, by contact with these eminent investigators, and the students that gathered about them, Gibbs returned to his native country for service in his profession, and found his first opportunity in the delivery of a short course of lectures in a minor institution in Delaware, but very shortly after, in 1849, he was appointed professor of chemistry in the Free Academy, now the College of the City of New York, where he remained until 1863, when he accepted the Rumford professorship, requiring service in chemistry, in the scientific school of Harvard College.

His term of service in New York was distinguished, for, while his duty to the college demanded only that he teach its students the elements of chemistry, he began in 1851 as associate editor of the *American Journal of Science,* the preparation of abstracts of foreign literature in chemistry, and he engaged in research, with the result than in 1857 there was given to the world the first memoir on a notable and systematic research in chemistry from America, when the Smithsonian Institution published the memoir of Gibbs and Genth on "The Ammonio-Cobalt Bases," which has ever since served as a model for the presentation of results by investigators in chemistry. In 1861 his independent paper on the platinum metals appeared and, as Clarke says, "firmly established his reputation."

Gibbs was in New York when our Civil War came on and, devoted as he was to his profession, he was also a patriot. It will be recalled that in broadly fitting himself for his profession he had at the College of Physicians and Surgeons pursued that branch of Applied Chemistry styled medicine and qualified in it, hence he could serve his country best and most by the exercise of his special knowledge and attainments. When men are rushing to expose themselves as targets for the enemy it requires a high degree of courage to offer on the altar of one's country one's special talents in service outside the firing line. But this Gibbs did and the U. S. Sanitary Commission stands to-day as an epoch in the civilization of man. By its work it proved, perhaps, to be the greatest good for mankind that was realized from that dreadful period of labor in which a great nation was born. It has been a model for other nations that have subsequently, unfortunately, been engaged in war.

Not content with applying his acquired knowledge, especially in that branch of applied chemistry known as medicine, to the amelioration of the "horrors of war" and to the aid of those that conquered, Gibbs sought to organize and crystallize opinion and effort by bringing together those of influence in New York who favored active military operations against the seceders and thus the Union League Club, which met, to organize, in his home, was formed. And throughout his life he was an organizer, or member, of bodies of men through which, by investigation, consideration and discussion, issues of moment in science were carefully wrought out, while social relations were conserved and promoted.

He was born and reared under conditions that could have bred an aristocrat. His father was in affluent circumstances. His progenitors had served their country and mankind in positions of importance. He inherited a competency. His associations from earliest youth were with the cultivated, intellectual and forceful. He was in person impressive and engaging. He was in taste and dress discriminating; but he was in his dealings with and estimates of man democratic.

As a prospective student I met him in 1868 and he looked to me god-like. It was my good fortune not only to be received as a student by him, but later to become his assistant and, through other fortunate circumstances,

such as being ordered to duty in Newport, where he resided after his retirement, to keep in contact with him quite up to the time of his death. I recall most vividly my first meeting with him, for he embodied in the flesh all that I had ever imagined of man, and though my relations with him were afterward quite close this feeling and belief persisted and remains. He was above the average man in height, and his body was symmetrically developed with his stature so that he walked and moved with natural gracefulness. His head was admirably proportioned and was covered with a splendid mass of curling black hair which matched the beard that covered his face. In clothing and person he was always decently fastidious, but ever the attracting features were his eyes, which were deep brown in color, lustrous and luminous; and his voice, which was full and rich, with a deliciously attractive and convincing overtone.

He gave the impression of mildness and fairness and continued association confirmed this first impression. Never have I met one who so avoided definitely judging his fellowman or who when forced to do so judged him more fairly and without prejudice, for his mind was filled with the contemplation of nature in a large way and of its processes, and he was endeavoring constantly to comprehend them and to record the results of his observations and tests for the benefit and use of mankind. He regarded his fellow man in the same broad and tolerant manner. In fact the definite impression of him which one received by close contact with him was largeness of vision; breadth of view; tolerance of differences in opinions, methods or manners; and sympathy, in a broad way, for mankind; and that he approached every issue, scientific or social, without prejudice, and with an entirely open mind.

If, in my attempt to portray Dr. Wolcott Gibbs from the image that abides with me, I have conveyed to you the impression that, through timidity or indolence he sought to avoid strife, let me hasten to immediately correct this erroneous impression, for on the contrary he was intensely human and he met his troubles in a thoroughly human way, but even then on a high plane.

Permit me to illustrate by an anecdote or two. Self-government by students is regarded in this country as a very modern and novel development. Dr. Gibbs introduced it at the outset of his coming to Cambridge. I do not know that he had not previously done so in the College of the City of New York. Eventually in my career as a student in his laboratory I succeeded to the first place in the governing body and I wore the resounding title of chief of police. During my administration a rebellion arose. The orders I gave were not obeyed and the fines I assessed were not paid. Having exhausted all the resources of authority at my command and the disorder having become a menace to all earnest students, after due warning, I resorted to the unheard-of expedient of reporting the recalcitrants to Dr. Gibbs. They were much amused when they were directed to report to this mild-mannered, sweet-tempered gentleman. I was not present at the interview. I never knew what occurred at that interview. The students never told me and Dr. Gibbs never referred to it. But what I do know is that when these students returned they said, "Munroe, you may order us to do what you wish; you may assess such fines as you please; but never again direct us to report to Dr. Gibbs," and from that day until I left the laboratory discipline was complete.

Strange as it may seem Dr. Gibbs became, on coming to Harvard, a storm center. President Hill called him because he had a vacant chair in chemistry to fill and he found in Gibbs the most eminent chemist in America. Gibbs accepted the position at Harvard because it seemed to offer the largest opportunity for usefulness in the field for which he was especially equipped. But his appointment thwarted the realization of the ambitions of others; it became a cause of dissension and the arraying of groups of men against each other. The situation had become acute as I entered upon the scene. In the

regular performance of my duties I was unwittingly forced to know of it, though then I knew not the reason for it or the extent of it. I was especially embarrassed to come upon Professors Gibbs and Cooke, when they were engaged in a gentlemanly, but very personal, altercation.

Unknowingly to me, out of this came my opportunity. While holding the position of private assistant to Dr. Gibbs I was appointed assistant in chemistry in the college under Professor Cooke. With the courtesy that prevails among gentlemen all these arrangements were ostensibly in the hands of Dr. Gibbs and it was from him that I received my instructions to make that visit to President Eliot at which I received notification of my appointment to the college. Naturally and most properly I reported to Dr. Gibbs that I had obeyed his instructions, and the results of so doing, and I can never forget his admonition. Knowing my loyalty to him, knowing that inadvertently I had become somewhat acquainted with the distressing situation, he said, "Mr. Munroe I have been deposed and you are appointed to take my place. You know that my relations with Professor Cooke have not been entirely amicable, yet let me say that you can serve me best by serving him with entire devotion." Thus spoke the man in Wolcott Gibbs.

Were there time I should like to describe the laboratory at the Lawrence Scientific School and the manner in which it was directed by Dr. Gibbs. Fortunately this has been well recorded by Professor F. W. Clarke in his memorial lecture before the Chemical Society of Great Britain and by Stephen Paschall Sharples in his description of the Lawrence Scientific School to the Cambridge Historical Society. I may say that were it to be investigated by an agent of the Carnegie Foundation, armed with a pad and pencil, it must have been condemned. I must further say that after completing my fortieth consecutive year of university teaching I should, if put under oath, state that, measured by pedagogical standards, it was unsound. But I must add that the results produced were splendid and that the students that survived the process went forth finely equipped to pursue their chosen professions. Dr. Gibbs's visits to us were infrequent, but the impression he made in these conferences were such that he was an ever-living presence and a constantly present example. Mendenhall's remark that a student would prefer to be neglected by Rowland to being taught by another embodies the thought I desire to convey concerning the relation of Wolcott Gibbs as a teacher to his students. The pedagogue trains his pupils as the military sergeant drills the cowherd. But the educator educes from his student his best capacities in the line of his endeavor. He brings the within without. He reveals to the student the latter's own capacities. He preserves to the community that precious gift, individuality, but arouses, and enlivens, and controls it so that it may best serve the community in which that individual may be placed. It is impossible to formulate the manner in which this may be accomplished, for the possibilities vary with each student to be taught and with him who teaches, and the teachers who comprehend this are rare, but such was Wolcott Gibbs.

It is said of Gibbs that he was not a "popular lecturer." I may say that this was most unfortunate for the populace. It has been my privilege to listen to a large number of those public speakers who have commended themselves to the public. As a youth I reported at length, for the newspapers, the lectures of Tyndall and Proctor. I served as demonstrator for Professor Cooke in that charming course of lectures at the Lowell Institute which appeared as "The New Chemistry." I sat at the feet of Edward Everett, Henry Ward Beecher, Wendell Phillips and Emerson. I was enthralled by Julia Ward Howe and Mary A. Livermore. Dr. Gibbs gave us but few lectures, but those were enriched by such a wealth of knowledge, graced with such diction, planned in so thoroughly logical and systematic a manner and presented with such

charming simplicity as to ever remain as almost unapproachable models.

For Dr. Gibbs was ever true to his best capacity (his proper sphere of usefulness to his fellows), namely, research, and he continued this long after his retirement from the field of teaching. As one reviews his achievements in research one is amazed at the catholicity of his accomplishments. All recognize his numerous contributions to analytical chemistry, his application of the electric current to quantitative determinations being especially well known; but he covered the field from gravimetric, through volumetric, to gas analysis. It is also pretty generally known that his early investigations of the complex ammonium bases, and their compounds, were in his later life supplemented by researches into the constitutions of the complex inorganic acids. Organic chemistry claimed his attention. In 1853 he prepared an arsenical derivative of valeric acid. In 1868 he discussed the constitution of uric acid and its derivatives. In 1869 he described some products formed by the action of alkali nitrites upon them. In 1891 and 1892, with H. A. Hare and E. T. Reichert, he treated of the physiological action of definitely related chemical compounds. He produced memoirs on a normal map of the solar spectrum and on the wave-lengths of the elementary spectral lines, and, in the study of interference phenomena, he discovered a constant, which he styled the interferential constant. The time allotted me is too brief to enable me to set forth the work of an investigator who at the age of eighteen published a paper entitled a "Description of a New Form of Magneto-electric Machine, and an Account of a Carbon Battery of Considerable Energy" and at seventy-one years of age published a method for the separation of the rare earths, further than to say that while Gibbs was an experimentalist rather than a theorist he published views on theoretical chemistry that have force to-day.

By virtue of his sympathy and breadth be became a pioneer in comprehending, assimilating and expounding the results of others, giving them always full credit. He was the first American to adopt and promulgate the conclusions of Cannizzario; so early as 1880 he appreciated the value of the researches of J. Willard Gibbs and was the prime factor in having the Rumford medal conferred on this immortal Yale physicist. I well remember his enthusiasm in those early days when speaking of the recently published, and now classic, memoir of Kekulé.

I fear the privilege you have afforded me to speak of my beloved master has tempted me to overstay the time allotted me and yet I feel I have but inadequately set forth the man and his achievements. In closing permit me to quote from the admirable tribute paid him by Theodore W. Richards:

> The circumstances of his early academic life brought him in contact with but few students. This is the more to be regretted because of his enthusiastic spirit, his tireless energy, his recognition of everything good, and best of all his warm human friendship which endeared him to all who knew him. Those who were thus fortunate, whether students or colleagues, will always devotedly treasure his memory; and his place as a pioneer in science in America will always be secure.

Charles E. Munroe

SCIENTIFIC NOTES AND NEWS

Alexander C. Humphreys, president of Stevens Institute of Technology, has been elected president of the American Society of Mechanical Engineers.

Mr. Emerson McMillin has been elected president of the New York Academy of Sciences. The vice-presidents for the sections are: Professor J. Edmund Woodman, Professor Charles Lane Poor, Dr. Frederic A. Lucas and Professor R. S. Woodworth.

The colleagues, friends and pupils of Professor Armand Gautier, professor of chemistry at the Medical Faculty of the University of Paris and president of the Academy of Sciences, on November 26, celebrated the fiftieth anniversary of his connection with the university.

Mr. W. Bateson, M.D., F.R.S., has been appointed Fullerian professor of physiology at

the Royal Institution, for a term of three years.

THE following have been appointed special lecturers on economic geology at McGill University, for the year 1912: Dr. W. Lindgren, United States Geological Survey; Dr. E. Haanel, Department of Mines, Ottawa; J. A. Dresser, Esq., M.A., the Canada Iron Corporation, Sault Ste. Marie.

DR. V. A. MOORE, director of the State Veterinary College, Cornell University, has been elected foreign correspondent of the Central Society of Veterinary Medicine of Paris.

As corresponding members of the Munich Academy of Sciences, there have been elected Dr. Bauschinger, professor of astronomy at Strasburg; Dr. Planck, professor of theoretical physics at Berlin; Dr. von Kries, professor of physiology at Freiburg; Dr. Roux, professor of anatomy at Halle, and Dr. Wiechert, professor of geophysics at Göttingen.

THE organizing committee for the Imperial University Congress to be held in London next July, have appointed Dr. Alexander Hill, M.D., to be secretary to the congress, in the place of the late Dr. R. D. Roberts. Dr. Hill was formerly master of Downing College, Cambridge.

THE special board for biology and geology at Cambridge University has adjudged the Walsingham Medal for 1911 to Mr. R. H. Compton, Gonville and Caius, for his essay entitled "An Investigation of the Seedling Structure in Leguminosæ"; and a second Walsingham Medal to Mr. Walter Stiles, Emmanuel, for his essay entitled "On the Podocarpeæ."

PROFESSOR ROBERT ORTON MOODY, of the department of anatomy of the University of California, is spending a sabbatic leave of absence in Europe.

MR. W. H. LONG, recently of the editorial staff of the *Experiment Station Record*, has accepted a position as forest pathologist in the Bureau of Plant Industry. He will have charge of the work in forest pathology in National Forest District 3, which comprises the national forests in the states of Arizona, New Mexico, Oklahoma, Arkansas and Florida.

MR. A. F. VASS has been appointed and has assumed his duties as assistant bacteriologist at the Oregon Agricultural College and Experiment Station. Mr. Vass is a graduate of the Kansas State Agricultural College and received his master's degree from the University of Wisconsin in soil bacteriology.

DR. ALFRED IRVING LUDLOW, a graduate of Adelbert College and of the medical department of Western Reserve University, professor of general pathology in the Dental School of Western Reserve University, and demonstrator of surgery in the medical department, and Mrs. Ludlow, sailed on December 19, for Seoul, Korea, to engage in medical educational work. He will be one of those in charge of the Severance Hospital and Medical College. The new building of the Medical College will be completed the first of the year and will furnish accommodations for a hundred students.

ACCORDING to a dispatch from St. Petersburg to the daily papers the Russian ban against the order of the Jesuits has proved a bar against the entry into that country of Father Pigot, who is particularly anxious to visit the Pulkova Observatory, in order to investigate seismological questions with Prince Galitzine. The British embassy, on behalf of the meteorological office in London, made special representations at the ministry of the interior, asking that the anti-Jesuit law might be relaxed, but all efforts have been unavailing.

DR. E. G. COOLEY, who as a representative of the Commercial Club of Chicago has recently visited Germany and has made an exhaustive study of conditions of vocational education in that country, has given a series of lectures at the University of Illinois on "Vocational Education in Germany." In addition to his regular lectures he held an informal conference with the faculty of the College of Engineering.

MR. R. J. YOUNG, of the North Chicago Works of the Illinois Steel Company, who is a member of the committee on safety devices

of the United States Steel Corporation, gave a lecture before the students and faculty of the College of Engineering of the University of Illinois on December 13, in which he described a large number of devices for protecting workmen against accident in steel mills. His lecture was profusely illustrated with lantern slides of devices in actual use.

The Linacre lecture at St. John's College, Cambridge, will be delivered by Sir Ronald Ross on January 19, on "Recent Work on Malaria."

Exercises were held at the Presbyterian Hospital, New York, on December 2, in celebration of the forty-third anniversary of the hospital. Dr. William H. Welch, of the Johns Hopkins University, delivered an address commendatory of the recent affiliation of the Presbyterian Hospital with the College of Physicians and Surgeons of Columbia University.

As we learn from the *Journal* of the American Medical Association, the appeal for the erection of a monument to Robert Koch has now been issued. As announced, the honorary presidency of the committee has been taken by the imperial chancellor while the acting president is the new chief of the state medical department, Professor Kirchner. To the committee belong, in addition to most of the members of the Prussian cabinet and the cabinets of the other states of the empire, the mayor of Berlin and the mayors of a large number of other cities, the most distinguished pupils of Koch and other notable persons. It is expected that the city of Berlin, of which Robert Koch was an honorary citizen, will contribute a large sum and furnish a place for the statue free of charge. On the part of the committee it is purposed to place the memorial on the Luisenplatz in front of the Kaiserin Friedrich-Haus for post-graduate instruction.

M. Henri Monod, former director of the public charities and hygiene in the French ministry of the interior and member of the Académie de médecine, has died, aged sixty-eight years.

Dr. Waldemar de Longuinine, professor of chemistry at the University of Moscow, has died at the age of seventy-seven years.

The American Society of Naturalists will, as already announced, meet at Princeton on December 28. In the morning the annual discussion will be on "The Relation of the Experimental Study of Genetics to the Problems of Evolution." The speakers will be: E. G. Conklin, Princeton University, "The Problems of Evolution and the Ways they May be Best Attacked"; C. B. Davenport, Carnegie Institution, "Light thrown by the Experimental Study of Heredity upon the Factors and Methods of Evolution"; W. Johannsen, University of Copenhagen, "Modern Exact Genetics in relation to the Problems of Evolution"; H. F. Osborn, American Museum of Natural History, "Unit Characters, Continuity and Discontinuity, as observed by the Paleontologist"; H. L. Clark, Museum of Comparative Zoology, Harvard University, "Pure Lines and Phylogeny." In the afternoon there will be a program of contributions to genetics. In the evening Dr. H. S. Jennings will give the presidential address on "Heredity and Personality."

The thirteenth annual convention of the Society of Sigma Xi will be held at Washington in affiliation with the American Association for the Advancement of Science. The council will meet on Wednesday, December 27, at 3:30 p.m. The convention will meet on Thursday at 3:30 p.m. at St. John's Parish Hall, on Sixteenth Street near H Street. The dinner will be held the same evening at 6:30, at the Tea-cup Inn, which is near by. Delegates and other members wishing to participate in this dinner will sign their names to a list for this purpose at the registration desk of the American Association for the Advancement of Science, where the list will be found for signatures until noon on Thursday. All members who sign will be welcome to the dinner, where reports of progress of chapters will be made. The business to be transacted will require an unusually long session. After din-

ner, business will be resumed and proceed until finished.

A LADIES' COMMITTEE for the coming Washington meeting of the American Association for the Advancement of Science and the affiliated and other societies meeting at the same time has been formed, with Mrs. Robert S. Woodward as chairman. Aside from the general functions, which will include a reception following the address of President Taft in the new National Museum on Wednesday evening, December 27, a reception at the Corcoran Art Gallery on Thursday night, December 28, by invitation of the trustees of the gallery, and an exhibition cavalry drill at Fort Myer, Virginia, on Thursday afternoon, the committee has arranged for a reception and tea at the Carnegie Institution of Washington on Wednesday afternoon at the invitation of Dr. and Mrs. R. S. Woodward. A tea to the visiting women will be given at the Cornell Women's Club of Washington at the residence of Mrs. Frederick A. Holton, 2125 S Street, Northwest, on Thursday afternoon. It is hoped that a tea can be arranged for Friday at the Washington Club. Professor and Mrs. Edgar Frisby will be at home to the members of the Astronomical and Astrophysical Society and accompanying ladies on Friday evening from 8 to 10 o'clock.

A FEW years ago, the American Association for the Advancement of Science decided to permit libraries desiring back numbers of sets of the American Association for the Advancement of Science *Proceedings* to have them up to a certain number on the condition of the payment of carriage charges by the receiving library. An announcement to this effect was published in SCIENCE at the time and a number of institutions responded. During the removal of the office in Washington, however, the list was unfortunately lost. Libraries which responded to the former request are urged to notify the permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C., especially stating that they are willing to pay the freight or express charges. The publications will then be sent. Other libraries desiring the *Proceedings* on these conditions are invited to notify the permanent secretary.

THE readers of SCIENCE will probably recall the obituary notice of Miss Matilda H. Smith published in the issue of SCIENCE for August 5, 1910, in which mention was made of the benefactions of the deceased and her sister, Miss Jennie M. Smith, to the American Association for the Advancement of Science by occasional payments of life membership fees for worthy scientific men of relatively small means. The permanent secretary has received word of the death of the sister, Miss Jennie M. Smith, and a copy of her will in which it is requested that the sum of $5,000 should be given to the American Association for the Advancement of Science, the said sum to be invested and the net income to be devoted to the creation of new life memberships in the Association. Under the terms of the will, similar bequests are made to the National Geographic Society of Washington and to the American Forestry Association of Washington. Other items in this will which are of interest to scientific men are as follows: $10,000 to the University of Pittsburgh, the income of which is to be used in the purchase of books and mineral specimens and the enlargement generally of the collection in the university known as "Smith's Collections." $10,000 to the Allegheny Observatory. $5,000 to the School of Liberal Arts and Sciences, the same to be invested and the net income to be devoted to the support of scholarships to be known as the Matilda H. and the Jane M. Smith Scholarships. $10,000 to the Allegheny General Hospital. $10,000 to the West Penn Hospital. The remainder of the estate is divided among her relatives and church and philanthropical organizations.

As has already been noted here an institution for furthering the progress of scientific chemistry without the obligation of teaching is to be founded at Dahlem near Berlin. The institute is to be erected jointly by a society consisting principally of proprietors of chemical factories and the state of Prussia. The

society guarantees a yearly contribution of $15,000 and for the building $225,000. The government gives the ground and promises to furnish one of the professors of the university as the director of the institution. The management of the new imperial institute is to be in the hands of a committee.

THE Rockefeller Institute for Medical Research, which owns all the property from Sixty-fourth to Sixty-seventh Street and from Avenue A to Exterior Street has secured from the city the title to Sixty-fifth and Sixty-sixth Streets from Avenue A to Exterior Street. While these streets have been laid out, they have never been cut through.

THE legislature of Pennsylvania last year appropriated $3,000,000 for its public health, $2,000,000 of which was to be expended in the fight against tuberculosis, and $1,000,000 to combat other diseases. The *Medical Record* states that during the past four years the number of deaths per annum has been decreased 14,000. It is estimated that about 2,500 deaths from typhoid fever and 7,000 from diphtheria were prevented last year by the activities of the State Health Department. The state maintains three sanatoria and 115 dispensaries for the treatment of tuberculosis and during the past year treated 40,000 cases of that disease. Taking the lowest estimated value of a human life, $1,700, it is calculated that the economic saving to the state through this reduction of the death rate amounts to $24,000,000 for the year. Preliminary arrangements have been made for the medical inspection of girls and boys in the third and fourth class school districts throughout the state. Five hundred physicians will be appointed to the task which embraces the examination of children in 321 boroughs and 460 townships.

THE following are the lecture arrangements at the Royal Institution before Easter: Dr. P. Chalmers Mitchell, a Christmas course of six illustrated lectures on the "Childhood of Animals," adapted to a juvenile auditory; Mr. W. Bateson, Fullerian professor of physiology, six lectures on the "Study of Genetics"; Professor E. G. Coker, two lectures on "Optical Determination of Stress and some Applications to Engineering Problems"; Dr. T. Rice Holmes, three lectures on "Ancient Britain"; Professor A. W. Bickerton, two lectures on the "New Astronomy"; Professor A. M. Worthington, two experimentally illustrated lectures on the "Phenomena of Splashes"; Mr. M. H. Spielmann, two lectures on the "Portraiture of Shakespeare"; Mr. F. A. Dixey, two lectures on "Dimorphism in Butterflies"; the Rev. John Roscoe, two lectures on the "Banyoro: A Pastoral People of Uganda"; Professor Sir J. J. Thomson, professor of natural philosophy, six lectures on "Molecular Physics." The Friday evening meetings will begin on January 19, when Professor Sir James Dewar will deliver a discourse on "Heat Problems."

UNIVERSITY AND EDUCATIONAL NEWS

BY the terms of the will of Mrs. Jan K. Sacher, who died in Oakland recently, the University of California is to receive $500,000. The will stipulates that $200,000 is to be spent on a granite campanile tower, 300 feet in height, to be erected in the center of the university grounds.

A HALF-MILLION endowment has been secured by Huron College, a Presbyterian institution in Huron, S. D.

ST. LAWRENCE UNIVERSITY has obtained a $200,000 endowment fund, of which the General Education Board has contributed $50,000.

A DEPARTMENT of veterinary science has been established at the University of Wisconsin, with Professor A. S. Alexander as head. Professor F. B. Hadley will assist Dr. Alexander in the work. Headquarters for the new department have been provided in the stock pavilion where a dispensary and operating rooms have also been provided. The courses in veterinary science are designed for students of agriculture and enable them to care for animals intelligently both in health and in disease, and to recognize the common diseases, blemishes and vices to which animals are subject.

THE mayor of Brighton, in a circular, quoted in the London *Times*, accompanying his invitation to attend a meeting to consider a proposal to establish a university at Brighton, says that by adopting the scheme suggested by Mr. Clayton, a member of the Education Committee, at the mayoral banquet last month, a university education would be brought within the reach of residents in Sussex who may prefer that their sons should receive university education within reach of their own homes. The Brighton Technical College and the new Training College provide a nucleus around which the scheme could be developed. It is suggested that there might be affiliation with the colleges at Portsmouth and Southampton to constitute a new university for the south coast, or that the present radius of the University of London should be extended to include the proposed new University College.

THE Rev. T. A. BENDRAT, of Turners Falls, Mass., has been appointed instructor in the department of geology at the University of North Carolina, his appointment taking effect on January 4, 1912.

ASSOCIATE PROFESSOR WILLIAM LLOYD EVANS has been made professor of general chemistry in the Ohio State University. The chemical department of the Ohio State University now consists of Professor William McPherson, head of the department, in charge of organic chemistry, and also dean of the Graduate School of Ohio State University; Professor William E. Henderson, professor of inorganic and physical chemistry; Professor Charles W. Foulk, professor of analytical chemistry; Professor William L. Evans, professor of general chemistry; Dr. James R. Withrow, associate professor of chemistry in charge of industrial and applied electro-chemistry; David R. Kellogg, instructor in general and physical chemistry, and Dr. John A. Wilkinson, instructor in analytical chemistry; together with six assistants and nine instructing fellows. There are in addition on the campus in separate buildings the department of agricultural chemistry and the laboratories of metallurgical chemistry, ceramic chemistry and pharmaceutical chemistry, including seven professors, one associate professor, four assistant professors and several instructors.

THE following have resigned their positions in Macdonald College, Province of Quebec: Mr. F. C. Elford, poultry instructor and manager, to take charge of the Educational Bureau of the Cyphers Incubator Co., Buffalo, N. Y.; Mr. J. M. Swaine, lecturer in biology, appointed assistant entomologist of the Dominion Experimental Farms in charge of work on forest insects; Mr. W. H. Brittain, assistant in biology, appointed assistant botanist of the seed division, Dominion Department of Agriculture; Mr. W. B. Cooley, assistant in animal husbandry, to go into private business in British Columbia. The following appointments have been made to the staff of the college: Mr. W. P. Fraser, M.A., Pictou, N. S., lecturer in biology; Mr. W. J. Reid, B.S.A., assistant in animal husbandry.

DR. J. H. BONNEMA, curator of the museum at Delft, has been called to the chair of geology at Groningen, to succeed Professor Van Kolker, who retires from active service.

DISCUSSION AND CORRESPONDENCE

ASTRONOMICAL REFERENCES IN TEXT-BOOKS ON PHYSICS

A SHORT time ago, having occasion to look into the treatment, given in some text-books on physics, of Roemer's method of determining the velocity of light, I was surprised to find a strange lack of information upon some simple definitions and well-known facts of astronomy. Thinking it well to call attention to this matter, I give below quotations from several books.

Glazebrook, "Light" (1894), pages 21 and 22: "Roemer discovered in 1656 that it travels with definite velocity." ". . . the period between two successive eclipses is known and is found to be 48 hours 28 minutes 35 seconds."

Jones, "Lessons in Heat and Light" (1892), page 197: "It happens that one of Jupiter's satellites (or moons) passes into the shadow of the planet at regular intervals (48½ hours), and is thus eclipsed."

Ames, "Theory of Physics" (1897), page 398: ". . . when the satellite will disappear behind Jupiter, i. e., be eclipsed."

Watson, "A Text-book of Physics" (1899), page 505: ". . . when Jupiter and the earth are nearest together (at conjunction), and that which occurs when they are at their greatest distance (opposition)."

Rowland and Ames, "Elements of Physics" (1900), page 172: ". . . and so, if the eclipses of a satellite behind a planet's disc. . . ."

Eggar, "Wave-motion, Sound, Light" (1901), page 504: ". . . the times of eclipse of one of the moons, i. e., the instants at which it should pass behind the planet and emerge from his shadow."

Crew, "Elements of Physics" (1906), page 311: "Jupiter has five moons, one of which is larger and brighter than any of the others, and is called the 'first satellite.'" See also "General Physics" (1908), page 429.

Henderson and Woodhull, "Elements of Physics" (1906), page 290: "The eclipse was seen while the earth and Jupiter were on the same side of the sun—as the astronomers say, 'in conjunction'—the time was 16′ 36″ earlier than when the earth and Jupiter were on opposite sides of the sun; that is 'in opposition.'"

Millikan and Gale, "A First Course in Physics" (1906), page 388: "Roemer was making observations on the largest and brightest of Jupiter's seven moons." "Roemer first determined the interval between two successive eclipses, . . . and found it to be 48 hr. 28 min. and 36 sec."

Gage, as revised by Goodspeed, "Principles of Physics" (1907), page 276: "He made observations on that one of the five of Jupiter's satellites which is nearest to the planet."

Duff (editor), "A Text-book of Physics" (1908), page 339: ". . . when Jupiter and the earth are in conjunction, or on the same side of the sun and in line with it." ". . . at opposition, when the earth is on the opposite side of the sun from Jupiter."

Leaving out of consideration the number of Jupiter's satellites at any date, each of the above quotations has one error and some of them two. In many books it is stated that Roemer found the time for the light to cross the earth's orbit to be 16 min. 36 sec. This is nearly the present accepted value, while that deduced by Roemer was considerably greater, some 22 min.

C. A. Chant

University of Toronto

AIR IN THE DEPTHS OF THE OCEAN

To the Editor of Science: With reference to the communications appearing in the issues of August 25 and October 27 in relation to "air in the depths of the ocean," while it is erroneous to hold that the amount of dissolved gas is dependent upon hydrostatic pressure, yet the gas content of the bottom waters may be greater than the gas content of the surface waters because of the greater solubility of the gases at the low temperatures prevailing in the depths of the ocean. Sea water contains, in proportions varying widely with circumstances, four gases—oxygen, nitrogen, carbonic acid and argon. The oxygen decreases and the carbonic acid increases with increasing depth; but there is a respiratory process in operation by which the carbonic acid ascends by diffusion right up to the surface, while the oxygen by the same means makes its way to the bottom. This allows us to understand how the supply of oxygen, which is indispensable to the life of the animals everywhere existing in the depths of the ocean, is renewed even down to the bottom and an exchange made between the carbonic acid gas produced by their respiration and the oxygen coming from above.

G. W. Littlehales

CONTAGIOUS ABORTION OF CATTLE

To the Editor of Science: In a recent number (October 13) Director H. L. Russell, of the Wisconsin Agricultural Experiment Station, announces the discovery of the fact that the contagious abortion of cattle in this country is identical with that of Europe, and due to the *B. abortus* of Bang. Professor Russell apparently regards the investigations carried out at the Wisconsin Station since May, 1911, as the first creditable bacteriological work upon this subject in this country, and his communication would seem to cast some doubt upon the accuracy of the observa-

tions and conclusions previously recorded by me.

The experimental evidence concerning the identity of the *B. abortus* isolated at the Illinois Agricultural Experiment Station in 1909 has been presented in several papers,[1] and, in connection with the literature reviewed in the same papers, seems to me to be conclusive. Cultures of the organism have been furnished to several laboratories in various parts of the country. A culture of this bacterium was requested by Professor E. G. Hastings, of the department of bacteriology, Wisconsin Agricultural Experiment Station, in March, 1911, and such a culture was sent to him on April 5, 1911.

W. J. MACNEAL
NEW YORK POST-GRADUATE MEDICAL
SCHOOL AND HOSPITAL

[1] MacNeal and Kerr, *Journal of Infectious Diseases*, 1910, Vol. 7, pp. 469–475. MacNeal, Society of American Bacteriologists, Ithaca meeting, 1910. Abstract in SCIENCE, 1911, Vol. 33, pp. 548–549; *Centrbl. f. Bakt.*, I. Abt., Ref., 1911, Bd. 49, pp. 390–391. Full paper in *Illinois Agriculturist*, March, 1911, pp. 8–14. MacNeal and Mumford, Illinois Agricultural Experiment Station Bulletin No. 152 (1911, in press).

THE MEETINGS OF SCIENTIFIC SOCIETIES

TO THE EDITOR OF SCIENCE: The reasons for isolating the meetings of the American Society of Naturalists, with its two affiliations, the Zoologists and Anatomists, from all other scientific organizations meeting during the Christmas recess seem to be as follows, judging from the chance statements of some of the officers of the societies: (1) Better facilities for delivering papers in the way of apartments, lanterns, etc.; (2) better living accommodations; (3) better chances for the members to become acquainted; (4) isolation from temptations to spread the interests over a wide field. If other reasons have been given, I have not heard them expressed.

Now, of these reasons, the first and second do not seem to me of any validity. A good lantern and comfortable meeting rooms can readily be obtained at any of the centers where the larger association meets and in regard to living conditions, I am quite sure that the cities where the American Association for the Advancement of Science meets can offer accommodations equal to those demanded by the most discriminating members of the Naturalists, Zoologists and Anatomists.

With regard to the third reason, I believe that this too, is of minor consideration—not because I do not value the social function of the meetings, for I am under the impression that this factor is paramount. What I mean is that smokers and hotel lobbies and the meetings themselves take care of this element quite well and well enough. If the officers and members who are solicitous in making the meetings a success will present themselves at the various functions rather than seek a quiet corner where they may enjoy the company of a chosen few of their friends to the exclusion of others who would care to meet them, I am quite sure that the third reason will pale into insignificance.

The fourth question seems to me to be the one which is cardinal. I am afraid that it is born of an indifference which certain members have towards any work in zoology or in biology in general which does not have certain relationships. If one will read over the programs of the Zoologists and Anatomists, he will find that papers upon topics of nomenclature, systematics, descriptive zoology and embryology, bionomics and some other subject matter are conspicuously absent from the one and that invertebrate topics are excluded from the other. This means that the rôle of these two societies is not to cover the legitimate field of zoology, but is limited to certain aspects; this is especially true of the Eastern Branch, but less true of the Central Branch of the Zoologists.

In the case of the Naturalists, the limitation of the field is more conspicuous than in the other cases, for here we have an organization which purports to be a nucleus around which the other biological societies are supposed to convene, whose field is more limited than any of the others! I am quite well aware that

there is difference of opinion with regard to the place that genetics holds in the interest of the average zoologist, anatomist, botanist, etc., but the assumption is, on the part of the officers of the Naturalists, that the field is sufficiently broad and fundamental to embrace the interests of men from all fields of biological work. Personally, I am interested in genetics, from the general standpoint, but the minutiæ are as technical and demand as close attention as any other field of biological work. The terminology and treatment of the science of genetics are changing daily and unless one take this as his special field of work he finds difficulty in following the discussions. There is another point, too, in this connection: I am not willing to admit that the data of genetics are any more fundamental than the data of other lines of endeavor, as for instance, the subject of development or of differentiation, or of metabolism, or one of a half dozen other things. Genetic development is but one group of phenomena in the ensemble we know as a living thing, even if it is an important one.

It is impossible for the Naturalists to justly solicit membership from botanists, geologists, psychologists, anthropologists and from other departments of science and expect these members to attend the meetings of the Naturalists when this organization meets in cities other than the one in which the special societies are meeting. At least it is not fair to the members of the other societies, who are at the same time members of the Naturalists. If it is the mountain and Mahommed, the mountain will not come to the prophet; of this I am quite sure.

Another point: The field of zoology is so wide and is so intimately connected with many other fields that no one cares to risk his reputation for logical thinking in fixing the limits of this science. Its devotees are not all embryologists, nor students of regeneration, nor of vertebrate anatomy; many of them are interested in animal psychology and others are interested in the physiological aspects of zoology, which stand on the border land between these sciences and zoology *sensu A.S.Z.* (!) Now meeting at Washington and in affiliation with the American Association for the Advancement of Science are several societies which yearly present papers of direct interest to our members, whose research in comparative psychology or animal behavior causes them to have this interest in the programs of the psychological associations, such as the American Psychological Association and the Southern Society. There are a number of papers presented before the Biochemists and Physiologists which are of interest to other members of the Zoologists and of the Anatomists. Now I wish to submit: Is it fair to these men to demand that they be loyal to the Zoologists and forego the pleasure and profit of attending such meetings in other departments as they desire? Do the reasons given above for isolating the meetings of the zoologists and anatomists compensate for this desideratum? I do not think they do.

It is my impression that there are a number of men whose views coincide with the ones expressed here and this is the *raison d'être* for this communication.

M. W. Morse

REGARDING PAYING THE EXPENSES OF STATION WORKERS TO SCIENTIFIC MEETINGS

The American Association of Agricultural Colleges and Experiment Stations at their meeting at Columbus in November passed the recommendation of their Committee on Station Organization and Policy, which reads as follows:

"At the request of one of the societies, with which members of the station's staffs would naturally be associated, the question of members of the staff attending the meetings of the scientific societies was discussed. Your committee believes that the leading members of the staff should, for their own sakes, so far as they are able, attend the sessions of at least one such society annually. It also believes that the station administration should be alive to the fact that there are frequently meetings and conventions at which the best

interests of the station demand that it be represented. In such cases, the proper official should be sent as the station's representative and at its expense."

This was brought to the attention of the committee by the American Association of Economic Entomologists, but of course applies to all divisions of the experiment stations. The details of such arrangements are to be regarded as matters belonging to the administration and they are naturally left to the officers of each institution concerned. The association can not, of course, dictate to directors or boards of trustees; the above is, therefore, to be regarded only in the light of a recommendation showing the sentiment of the association.

F. L. WASHBURN,
President of the Am. Assoc. of Economic Entomologists

SCIENTIFIC BOOKS

Introduction to Psychology. By ROBERT M. YERKES. New York, Henry Holt & Co. 1911. Pp. xii + 427.

The Essentials of Psychology. By W. B. PILLSBURY. New York, The Macmillan Company. 1911. Pp. xi + 362.

An Introduction to Experimental Psychology. By CHARLES S. MYERS. Cambridge, University Press. 1911. Pp. vi + 156.

Elements of Physiological Psychology. By GEORGE TRUMBULL LADD and ROBERT SESSIONS WOODWORTH. (Thoroughly revised and rewritten.) New York, Charles Scribner's Sons. 1911. Pp. xix + 704.

The present year has been an unusually fruitful one in systematic works on psychology. Of the above-noted four text-books in English, three are by Americans. One is an elementary introduction to experimental research, another is a compendium of physiological psychology, and two are general outlines of psychology by writers long known for their special contributions, who have not hitherto given us surveys of the whole science.

The works of Yerkes and Pillsbury form an interesting contrast in standpoint. Professor Pillsbury, trained in a school which regards introspection as final arbiter, takes a remarkably objective attitude in his book. Psychology is treated as the science of behavior, and the structure and functions of the nervous system receive prominent attention. On the other hand, Professor Yerkes, whose investigations in animal psychology would suggest a predilection for objective criteria, proves to be an out-and-out introspectionist, and omits the customary discussion of the nervous system on the ground that it does not belong in a psychological text-book; nervous structure and animal behavior are merely "signs of consciousness."

Professor Yerkes's book is a capital introduction to scientific psychology. It outlines the fundamental facts, emphasizing the classic "descriptive" psychology, but at the same time seeking to familiarize students with the more important experimental and genetic work. Of its six parts, the first is introductory and discusses the scope and methods of the science; four deal with particular aspects of psychology; while the last part indicates some practical applications.

Part I. examines the relations of psychology to physical science. The data are shown to be substantially the same; but physics and chemistry treat the common material from the objective standpoint, while psychology views it subjectively. It is on the basis of this distinction that the author emphasizes introspection and subordinates behavior to consciousness throughout the work. This part contains an unusually interesting critique of scientific method, well worked out, though possibly too detailed for beginners. In place of the usual terms "observation" and "experiment," the distinction is more logically entitled "naturalistic" and "experimental" observation (p. 45).

Part II. is devoted to descriptive psychology. Professor Yerkes is a champion of the structural psychology, and believes that the first aim of the science is to discover the constitution of consciousness. His account of the

elementary sensations and feelings is well analyzed. He considers sensation and affection distinct classes, since the former possesses "a sort of local mark" which "affection lacks" (p. 147). In discussing the properties attributed by various authors to sensations and affections the writer is remarkably free from bias (pp. 104, 151). He advocates the word "mode" to indicate the fundamental sorts of sensation. Such distinctions as noise and tone are different modes within the same sense. Several tables are given of the senses and their modes (pp. 95–100), and here as elsewhere the tables are excellently presented. The synthetic discussion is good so far as it goes; but unfortunately it stops with perception and imagination. There is no adequate treatment of thought.

In Part IV. Professor Yerkes brings together a remarkable number of psychological generalizations and laws. This portion of the book deserves special study, in view of the claim in various quarters that psychology is not an exact science. The author is at his best here. He notes fifteen laws of sensibility (threshold, contrast, local sign, etc.), three laws of perception, and several laws relating to the affective life, attention and association. The collection and formulation of these laws is a valuable contribution to the science.

Part V. extends these laws to wider generalizations or "explanations" of mental phenomena. The author adopts the parallelistic view, which demands that psychology study psychical events by themselves, before attempting to correlate them with physical happenings. "The essence of the causal relation is uniformity of the order of events" (p. 328). It is found that sensation always precedes the after-image, disagreeable affections are "called up" by sensations, etc. (p. 334). On the very basis, therefore, on which we accept physical causation, these must stand as instances of psychical causation, and we can affirm that "certain mental conditions bring about the formation of an idea, an emotion, a judgment" (p. 336).

Parts II., IV. and V. belong together, and the interpolation of the genetic discussion (Part III.) is a break in continuity. However much the reader may sympathize with the author's desire to introduce genetic notions as early as possible, he will feel that the presentation of this topic should follow Part V. The phylogenetic account, although brief, is clear and thorough, as one would expect from a writer of Professor Yerkes's training and sympathies. Nevertheless, one misses the help which a discussion of behavior at this point would have afforded. This is left till Part V., where the relations of behavior and consciousness are considered in detail. The ontogenetic chapter is somewhat meager. The main stages of mental development from infancy to maturity are examined, but there is no attempt to trace the actual course of individual development. Part VI., on the control of mental life, supplements this chapter. The author points out the relation of psychology to education and eugenics, illustrating the effects of good and bad heredity by the striking contrast between Jonathan Edwards's descendants and the notorious Jukes family.

Failure to examine the thought processes is the only important omission. The cursory treatment of volition and other aspects of the motor life is in logical keeping with the author's purpose to subordinate behavior to consciousness. A novel distinction suggested between lightness and brightness (p. 122) is the only departure from accepted positions which introspection is likely to challenge. The volume shows careful preparation and abounds in good illustrative examples. Excellent judgment is used in the selection of material, and opposing standpoints are presented with remarkable fairness. There are innumerable citations and quotations, especially from recent writers. At the end of each chapter is a class exercise, usually related to the subject matter, which serves as an introduction to experimental methods. The clear style and skillful avoidance of technical expressions make the volume especially suitable for beginners.

Psychologists will welcome Professor Pillsbury's systematic attempt to treat human psychology in terms of behavior. It is unusual for a text-book on psychology to view human activity from an objective standpoint, and it is not easy to retain this point of view consistently.

The author defines psychology as "the science of human behavior" (p. 1). This limitation of the field is open to two objections: (1) it seems to exclude animal behavior from psychology, which is particularly undesirable in an objective discussion; and (2) it apparently discriminates against introspection. The latter criticism, however, is met by a broad use of the term "behavior"; Professor Pillsbury treats mental processes as antecedents of behavior, and includes the usual discussion of sensation, perception, memory, feeling and other phenomena of consciousness.

The structure and functions of the nervous system are thoroughly discussed in two chapters. The real nervous basis of consciousness is found in the synapses. According to this view, habit-formation probably involves a permanent lessening of tension at the synapse, rather than a modification within the neurone. The author seeks to mediate between functional and structural psychology. All psychological facts are reduced to three fundamental principles: "The first is that all mental qualities come originally from sensation. . . . The second principle is that the order in which mental processes of any sort enter consciousness and whether any process does or does not enter consciousness, depends upon the nature of the individual rather than upon the forces in the physical world. . . . The third and last of these principles is that experiences leave a disposition in the nervous system that tends to the reinstatement of that experience on suitable occasion" (p. 153). This provides three elementary facts—sensation, attention and retention—which may be regarded as either elements or processes.

Sensation, according to the author, stands in a specially close relation to the nervous system. "The development of the sense qualities depends upon and goes hand in hand with the development of the sensory endings. In the simplest organisms there is no differentiation of sensory organs, and consciousness probably shows no differences whatever" (pp. 62–63). The rise of the four skin senses is described first, then the higher senses, finally the kinesthetic, static and organic. The intricate topic of vision is exceedingly condensed, and the author scarcely does justice to the difficulties which have produced rival theories. We find here the parodoxical statement that "the retina is a part of the brain that in the course of development has come to the surface" (p. 86, cf. p. 132).

The chapters on feeling and emotions are very suggestive. The author makes feeling distinct from sensation: "Feelings are subjective, sensations objective" (p. 260). It is not clear how this can be reconciled with the earlier statement that "all mental qualities come originally from sensation" (p. 153). Nor does the position of these chapters furnish a clue; they follow instinct, which comes after perception, memory and reasoning, though the emotions are regarded as "intermediate between feelings and instincts and the higher intellectual operations" (p. 272).

After discussing sensation, attention and retention Professor Pillsbury proceeds to more complex phenomena. The chapter on perception contains a very full account of visual space perception and optical illusions. By some oversight tactual space is omitted. The chapter on memory and imagination contains a very helpful discussion of the laws of learning and the laws of retention and forgetting. On the neural side "learning is the result of producing changes in the synapses, retention depends on the persistence of the impression; forgetting, upon its disappearance" (p. 194). The author is strongly opposed to artificial memory systems, which in his opinion require more effort than they save.

The analysis of intellect and its growth needs amplification. Imagination is treated in about a page, while abstraction is given no independent examination whatever. The dis-

cussion of these processes scarcely affords an adequate basis for the reasoning process. On the other hand, the relation of reasoning to memory and imagination is shown in a particularly striking epigram: "The results of reasoning are new and are accepted as true; the results of memory are true, but not new; and the results of imagination are new, but not true" (p. 217). Professor Pillsbury regards belief as bearing "the same relation to reasoning that recognition does to memory" (*ibid.*).

The student will find the chapter on instinct especially helpful. "Instinct and reflex are to be distinguished in terms of the simplicity of the reflex and the complexity of instinct; by the fact that the reflex can be understood from the mechanical activity of the nervous structures, while the instinct can be referred to its purpose alone; and in the amount of consciousness that attaches to the instinct. . . . In instinct, ordinarily, all is conscious but the reason for the act" (pp. 254–255). The writer distinguishes between individualistic, racial and social instincts, with a suggestive discussion of each.

After the chapters on feeling and emotion the author passes to action and will. Recent work on the acquisition of skill is described; but interest is centered on the control of activity. The writer emphasizes the importance of developing a system of ideals in the individual in order properly to train his will. Work, fatigue and sleep are treated in a single chapter, with an account of the physical effects of fatigue and a curve illustrating depth of sleep.

The two concluding chapters give the broader aspects of the subject. Professor Pillsbury discusses the interrelations of mental functions, with some forcible criticisms of the faculty psychology. "Mind is not a collection of unrelated faculties and . . . it is not a single force or faculty" (p. 341). Experimental research alone can determine whether and how far the training of one function is transferred to another. The author defines three separate aspects of the self, as a continuous existence, as accumulated habits, and as unity of experience.

Dr. Myers's book is precisely what its name implies—an introduction to experimental psychology. It is intended for the beginner and sums up the most representative and interesting results. The presentation is clear and avoids mathematical discussions which are liable to perplex the novice. The whole topic of psychophysics is omitted, and there is no attempt to describe the technique of experimental research. This narrowing of the field is made up for by several features not usually introduced into an experimental text-book. In a number of cases the laboratory data are compared with results obtained from savage races; under the head of cutaneous sensations the author discusses certain pathological conditions which bear on the number of distinct dermal senses; and in describing mental tests stress is laid on the study of individual differences. Considerable of the data on mental tests, esthetics, etc., in this book are not found in the author's larger text-book. All this gives the beginner a wider perspective than if he were confined to the usual laboratory results.

The first chapter sums up the evidence for ascribing several distinct senses to the skin, and can not fail to impress the reader brought up to believe in the traditional five senses. Some of the more striking facts of color vision are discussed in Chapter II. The author alludes (p. 29) to the color terminology in Homer, as indicating a restricted color sense among the ancients. In the next chapter several forms of the Müller-Lyer illusion are illustrated. This and the succeeding topic of esthetics are perhaps treated at disproportionate length; but the chief purpose of the book is to interest the reader in experimental psychology, and one is justified in sacrificing symmetry to this more important aim. The well-known memory experiments are outlined in Chapter V., and the author points out the practical value of knowing how to memorize in the best way.

The last two chapters are devoted to individual tests, including visual acuity, sensory discrimination of various sorts, tests of mental and physical work and fatigue, and association tests. Dr. Myers describes in full the Binet tests, which have recently attracted such attention in this country, and concludes with an explanation of the methods used in correlating different sorts of tests. All his descriptions of tests are very clear, though in one table (p. 98) the value of the standard is inadvertently omitted.

A short bibliography is appended, which seems rather condensed and general for collateral reading. The text will certainly impress the reader with the value of the science, and stimulate him to take up work in the laboratory.

Those of us who were first introduced to physiological psychology through Ladd's "Elements," will be pleased to see that classic work revised and brought thoroughly up to date. Professor Woodworth, who is in close touch with recent neurological research, is associated with Professor Ladd as joint author. The edition in no way yields to the old as an accurate compendium of facts. The length remains about the same. To make way for the wealth of new material much of the old has been condensed. In its new form the book contains a mass of anatomical and physiological facts which every psychologist needs to know—facts which he would otherwise have to gather laboriously from many different sources. To give a single instance: the number of fibers in the dorsal and ventral spinal roots of the frog, and of fibers in the dorsal roots of man, are taken from separate magazine articles which the psychologist would not readily find (p. 75). Authorities are freely cited in footnotes. As in the old edition, the theory of mind and matter is given a prominent place; but the philosophical standpoint never biases the statements of anatomical or physiological fact.

The present work, like the earlier edition, is divided into three parts. The first part, about 300 pages, is devoted to anatomy and general physiology. The second part, slightly longer, embraces what is now known as experimental psychology. It contains an excellent compendium of results from the psychological laboratory, carefully selected and more suitably arranged than even the historic "Grundzüge." The third part, on the "nature of mind," has been considerably shortened. The subject index is unusually good, but the text itself is not easy to consult, for the chapters in each part and sections in each chapter are numbered separately, instead of continuously through the book. Placing the chapter number at the head of the page would have facilitated reference work considerably. Recent terms, such as distance receptor (p. 25) and archi-pallium (p. 31) are used so far as they have been sanctioned, and other new terms, not generally accepted, are mentioned in footnotes; thus, a list is given of the nervous tracts named according to their place of origin and termination (p. 89).

Part I. opens with a new chapter on the evolution of the nervous system from ameba up. The vertebrate and invertebrate types of brain are compared, and an interesting table of brain weight and body weight is copied from Warnecke (p. 34). Chapter II. contains a very explicit account of the development of nervous system and end organs in the human individual, followed by two chapters on grosser and finer nerve structures. The control of each hemisphere over the opposite side of the body is explained with special clearness in the complicated case of vision: "Since the rays of light cross within the eyeball, the right half of each retina receives light from the left side, and therefore the right half of the brain receives the impressions that come from the left side" (p. 92). Another new chapter describes the chemistry of the nervous system, which is seldom brought to the notice of psychologists. This is followed by a discussion of nervous conduction.

Chapter VII. treats of reflex and automatic functions. The authors regard *reflex* as a relative term. "The fatality and predictabil-

ity of reflex action have sometimes been overstated" (p. 173). They hold that the activity of the nervous system in its highest forms is "preeminently *automatic*. It is, therefore, highly probable that the reflex and the automatic forms of its functioning are most frequently, if not uniformly, combined in ever-varying proportions" (p. 149).

Taking up the end organs, a résumé of anatomical investigations indicates that the several cutaneous organs are by no means so definitely identified as psychologists often imagine. The human eye is wittily described in true advertising style as "'a wonderfully compact little instrument, capable of being focused on any distance from five inches upward, provided with the only original iris diaphragm, and having the special feature of a self-renewing plate, which automatically alters its sensitivity to suit the illumination, and also gives colored photographs. The camera can not, however, be guaranteed, as some specimens are defective, and even the best are liable to be injured by hard usage; none will be replaced, though some of the defects can be partially corrected'" (p. 196).

Two chapters are devoted to localization of functions in the cerebrum. At the present time, "the 'motor area' is definitely located; the 'visual area' is likewise; and the location of the areas for hearing and smell is only a little less definite" (p. 234). "It is probable that our ordinary movements of the eyes in looking at an object, *i. e.*, in directing the center of clear vision upon it, are reactions through the visual area, and not through the motor area" (p. 249). "Excitation of the temporal lobe, in animals, gives rise to movements of the ears. . . . These are, in appearance, 'listening' movements, and their occurrence indicates that the primary motor adjustment to sound occurs through the auditory area rather than through the motor area" (p. 250). The limitation of the speech functions to the Broca area does not seem justified (p. 259). Unusual emphasis is laid on differences in anatomical structure within the cortex: "The fact that a uniform structure exists over any considerable area of the cortex, giving place at its borders to areas of other structure, would seem plainly to indicate that within each area the elements have something in common in the manner of their functioning" (p. 273). The authors believe that we need, "on the physiological side, a more detailed knowledge of the structure of the cortex as a whole, and in its different parts; and, on the psychological side, a thorough analysis of such vague and gross so-called functions as 'speech,' or 'skilled movement,' or 'perception of objects,' or 'orientation in space,' into their elementary functional factors" (p. 264).

The concluding chapter of Part I. discusses the mechanism of the nervous system. Preference is given, as in Pillsbury's work, to the synapse or cell-boundary theory, which seems, "when worked out in detail, to be more capable of giving an expression in physicochemical terms to most of the known peculiarities of central function than any other theory which has been put forward" (p. 290).

The quantitative results of psychophysics, in Part II., are compressed into a single chapter. The authors are inclined to minimize the importance of Fechner's law. "It is not so much . . . a law of absolute quantity of sensations as dependent on stimuli, but rather a law of our apprehension in consciousness of the relation of our own feelings" (pp. 375–6). "Granted that it is no longer considered as giving a measure of sensation; it may be retained as indicating the position of a sensation in the scale of intensities. . . . It seems better, then, to drop Fechner's logarithmic law, and abide by the more empirical expression of Weber" (p. 378).

Two chapters are devoted to sense perception, in which a middle ground is chosen between nativism and empiricism. Visual space perception is examined thoroughly, with considerable stress upon eye movements, though the motor theory is not accepted in its entirety. The survey is confined to space perception; but this limitation does not appear in the definition: "Perception is the result of an extremely complex activity of the psychical

subject, Mind; it involves a synthesis of a number of sense-data according to laws that are not deducible from the nature of the external objects, or of the physiological actions of the end-organs and central organs of sense" (p. 468).

On the affective side, the authors hold to an "almost infinite variety of, not only our complex feelings, emotions and sentiments, but also of those" simpler feelings which have hitherto resisted analysis. Pleasantness and unpleasantness are regarded as merely the "tone" of feeling (p. 515). The esthetic feelings are treated at considerable length, while the moral feelings are only briefly mentioned. The chapter on memory gives the classic results on learning and includes a reference to Freud's new method of psychoanalysis for bringing submerged complexes to the surface (p. 586). The behavior of animals in learning mazes, etc., is described, and curves of human learning and forgetting are reproduced. The mechanism of thought is the subject of the last chapter in this part.

Part III., as in the earlier edition, takes a frankly dualistic attitude. "The two existences, body and mind, may not be identified by the science which investigates their correlations. . . . They are, however, dependently connected. Each stands in causal relations to the other; although this dependence appears to be by no means complete" (p. 653).

One can scarcely overestimate the labor involved in reconstructing such a work as this, written before the neurone theory was formulated, or the evolution of the brain worked out. The revision has been thorough, however, and the "Elements" becomes once more a standard reference-book for the experimental psychologist.

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A Text-book of Physiological Chemistry. By OLOF HAMMARSTEN, Emeritus Professor of Medical and Physiological Chemistry in the University of Upsala. Translation from revised seventh German edition by JOHN A. MANDEL, Sc.D., Professor of Chemistry in the New York University and Bellevue Hospital Medical College. Sixth American edition. New York, John Wiley & Sons. 1911. 8vo. Pp. viii + 964. Cloth, $4.00 net.

No familiar text-book of physiological chemistry published in recent times presents the interrelations between chemistry and physiology, between organic structure and function, in the effective way that Professor Hammarsten has followed through many editions. To the organic chemist a presentation like that of Röhmann's "Biochemie" may appeal because of its distinctively chemical viewpoint; but to the biologist and physician who are interested above all in the activities of living organisms, the emphasis upon function rather than composition is more acceptable and inspiring.

While others have compiled in cyclopedic handbooks of considerable magnitude the individual chapters of biochemistry prepared by diverse eminent contributors, Professor Hammarsten has continued to retain that comprehensive grasp upon the literature of this subject which has enabled him to condense into a single volume the essential facts of the science. To say that most workers in this field still turn to Hammarsten's "Text-book" as the readiest exponent of both the permanent acquisitions and tentative ideas in chemical physiology, is to pay a just tribute to its author's useful contribution as an educator.

There are signs of the expansion of the details of the science beyond the grasp of one individual. For the first time, a chapter (Physical Chemistry in Biology, by Professor S. G. Hedin, of Upsala) has been prepared by a collaborator. It is a readable presentation of topics—such as osmotic pressure, colloids, catalysis, enzymes, ions and salt action, in their physicochemical bearings—which are not always offered to the untrained appetite in a palatable form.

Without referring in detail to a book of which the essential features must be familiar to many, the reviewer ventures the opinion that the excellent chapter on metabolism is

not as widely appreciated as it deserves to be. There are few comparable or equally comprehensive outlines of the subject published in English. This chapter may serve also to illustrate the effectiveness of the revision which has been practised in the new edition. Not only are new facts introduced (American investigations not being overlooked), but discarded and unsubstantiated views have been conservatively eliminated. For example, there are found detailed allusions to the studies in "artificial" nutrition, Michaud's experiments on the protein minimum, Rubner's recent discussions on nutrition, Murlin's study of gelatin feeding, and the disputed problem of the specific dynamic action of foods. The discussion of obsolete obesity "cures," etc., has been omitted.

In the translator's preface Professor Mandel writes: "The work of translating and editing has been a labor of love, inasmuch as I feel that it will be of aid in the advance of this department of chemical science." He is right, and deserves a renewed expression of appreciation from biochemical workers for the faithful and correct execution of an uninviting task.

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SPECIAL ARTICLES

ON THE NATURE AND SEAT OF THE ELECTROMOTIVE FORCES MANIFESTED BY LIVING ORGANS[1]

1. When an organ of an animal or a plant is injured an electromotive force develops between the injured and the non-injured surface, the latter being, as a rule (if not always), positive to the former. Loeb suggested in 1897 that this difference of potential might be due to the fact that the injured spot formed an acid and that on account of the H-ion moving faster than the anion a difference of potential was produced. This assumption accounted for the sense of the E.M.F. in a partially injured organ. It was, however, pointed out that the order of magnitude of such diffusion elements is too small to account for the E.M.F. found in living organs. Wilhelm Ostwald had suggested the possibility that living organs form concentration elements with a solid phase interposed, the solid phase —the membrane—being permeable for certain ions only. Bernstein starting from Helmholtz's conception of free energy conceived the idea that measurements of the effect of temperature on the E.M.F. of a partially injured muscle or nerve might indicate the nature of the elements to which these systems belong. He reached the conclusion that the partially injured muscle belongs to the type of concentration element in which a solid phase—the membrane—separates the two liquids, the solid phase being only or more permeable to kations than to anions, thus corroborating Ostwald's suggestion.

Bernstein found that the E.M.F. of the muscle rises in general with the temperature and that it approaches a value in proportion to the temperature. The agreement was, however, not as good as should be desired to put the theory of concentration cell of the muscle current on an absolutely safe basis. Moreover, experiments on nerve were less satisfactory and in both cases accessory assumptions were required to make the actual results agree with the theory.

2. Muscles and nerves are, perhaps, too variable or rather perishable to investigate quantitatively with any degree of satisfaction the nature and origin of their E.M.F. We selected for this purpose a hardier and more constant object, namely, apples, the surface film of which is strong and which remains sufficiently constant during such an investigation. Instead of testing the effect of temperature on the E.M.F., we selected the effect of the concentration of the solutions in contact with the apple. The limit within which the temperature can be safely changed without injuring or modifying the living organ is very small and this is one of the reasons why Bernstein's figures are not quite satisfactory, as he himself recognized; while we can change the concentration on such living ob-

[1] Preliminary communication.

jects as the apple in very wide limits without injury or complicating alterations.

We found the following method most satisfactory. An apple with perfect skin was put into a glass dish containing a small amount of a liquid *a*. On the opposite side of the apple a piece of the skin and the underlying tissue was removed and into the hole was put a small quantity of a liquid *b*. The latter remained constant throughout the experiment, while *a* was changed according to the nature of the experiment. Both liquids *a* and *b* were connected with calomel electrodes and the E.M.F. was determined by Poggendorf's compensation method (capillary electrometer). The temperature was kept practically constant (about 19° C.).

We, therefore, were studying the E.M.F. of the following system: liquid *a;* apple; liquid *b,* the membrane of the apple being the solid phase between liquids *a* and *b*. According to the theory a fivefold dilution of *a* should always give a constant decrease of E.M.F., namely, .040 volt; and a tenfold dilution should decrease the E.M.F. always by a value of .058 volt. These values may be expected to be smaller if the ideal conditions of semipermeability are not fulfilled.

In the following experiment liquid *b* (in the apple) was *m*/10 KCl. Liquid *a,* on external surface, varied in concentration. The calomel electrodes contained *m*/10 KCl. The

TABLE I

Concentration of Liquid *a*.	E.M.F.
m/10 KCl	+ .040 volt
m/50 KCl	+ .068 volt
m/250 KCl	+ .103 volt
m/1,250 KCl	+ .137 volt
m/6,250 KCl	+ .169 volt

sign + means that liquid *a* was positive to liquid *b*. In this experiment each successive liquid was five times as diluted as the previous one and the theory demands that the difference of E.M.F. between two successive solutions should be identical. If we compare the interval from *m*/50 to *m*/6,250 this is true. A dilution from *m*/50 to *m*/250 increases the E.M.F. by .035 volt; from *m*/250 to *m*/1,250 by .034 volt; from *m*/1,250 to *m*/6,250 by 0.32 volt. By diluting from *m*/10 to *m*/50 we find .028 volt, which is a little too small. We have found it to be generally true that as soon as we work with more concentrated solution than *m*/50 the differences are a little smaller than the theory demands. Whether this is due to the decrease in ionization or to an injurious effect of the solutions of higher concentration upon the skin of the apple we are not yet prepared to state.

The values observed are all a little smaller than we should expect. According to Nernst's formula the difference of potential for a dilution of five should be .040 volt, while we found a difference of .033 volt. The fact that we did not get the maximum potential difference is, perhaps, due to the fact that the skin of the apple is not completely impermeable for anions.

Experiments with other salts gave similar results as far as the effect of concentration was concerned.

3. The sign of the E.M.F. of the system electrolyte; apple; electrolyte was always in that sense as if the membrane of the apple were more permeable for kations than for anions. In order to test this possibility the electromotive effects of NaCl were compared with those of Na_2SO_4. If our assumption were correct the E.M.F. of a NaCl solution should always be equal to the E.M.F. of a Na_2SO_4 of half the concentration of the former. The following example shows that this is actually the case. The internal liquid *b* remained constant throughout the experiment *m*/10 KCl. The external liquid *a* varied according to Table II.

TABLE II

Liquid *a*.	E.M.F.
m/10 NaCl	+ .038 volt
m/100 NaCl	+ .090 volt
m/1,000 NaCl	+ .139 volt
m/2,000 Na_2SO_4	+ .141 volt
m/200 Na_2SO_4	+ .092 volt
m/20 Na_2SO_4	+ .044 volt

This experiment shows that whether the anion is Cl or SO_4 as long as the concentra-

tion of the kation remains the same the E.M.F. remains unaltered. The E.M.F., if liquid *a* is *m*/1,000 NaCl, is .139 volt, and if it is *m*/2,000 Na_2SO_4 is .141 volt; practically identical values. If the liquid *a* is *m*/100 NaCl it is .090 volt, if it is *m*/200 Na_2SO_4 it is .092 volt; again practically identical values.

4. It was necessary to convince ourselves that we were not dealing with purely osmotic effects (and possibly diaphragm currents). In one experiment the external liquid *a* was *m*/100 NaCl, the liquid *b* on the injured side of the apple was *m*/10 KCl. The E.M.F. was + .092 volt. Then enough cane sugar in crystals was added to the liquid *a* to make its total concentration about *m*/2. After the sugar was dissolved the E.M.F. was .093 and remained so. Changes in concentration by a non-electrolyte like cane sugar, therefore, do not alter the E.M.F.

5. Continuing an investigation by Haber and Beutner on "Phasengrenzkräfte," Haber and Klemensiewicz described a concentration cell for H-ions of the type, acid; glass; alkali, the acid representing the solution with a high, the alkali with a low concentration of H-ions. Haber pointed out that this type of concentration element might correspond to the type represented by muscle, the muscle fibrils corresponding to the glass in the acid alkali element. Since the liquids in the cells are practically neutral a slight production of acid in the fibril (or the injured spot) would give rise to a considerable E.M.F. We fully expected at the beginning of these experiments to find that the E.M.F. of living organs was of the type of that found by Haber. We found, however, that for the apple this is not the case, as the following experiment shows. The internal liquid *b* was throughout the whole experiment *m*/10 KCl (neutral). The external liquid *a* was in succession *m*/20 NaCl, neutral, alkaline, acid and alkali again. It was rendered acid through addition of enough HCl to render the *m*/20 NaCl solution *m*/1,000 acid, and it was rendered alkaline through the addition of enough NaHO to render the *m*/20 NaCl solution *m*/1,000 alkaline.

TABLE III

Liquid *a*.	E.M.F.
m/20 NaCl, neutral	+ .051 volt
m/20 NaCl, *m*/1,000 alkaline	+ .052 volt
m/20 NaCl, *m*/1,000 acid ..	+ .048 volt
m/20 NaCl, *m*/1,000 alkaline	+ .052 volt

The differences found between neutral, acid and alkaline *m*/20 NaCl are slight and within the limits of purely accidental variations. If we were dealing with a reversible cell in regard to H-ions we should expect a difference of almost .5 volt between *m*/1,000 acid and *m*/1,000 alkali.

6. It may be of interest to mention also that acids and alkalis behave in regard to the E.M.F. to which they give rise like the salts. The experiments we made in this respect show also that if the concentrations of these substances are a little too high the regularity of the results suffers, and the irregularities are always of such a nature as should be expected if the injury or the etching effect of acids and alkalis increased the anion permeability of the skin of the apple. Liquid *b* in the apple was *m*/10 NaCl throughout the experiment.

TABLE IV

Liquid *a*.	E.M.F.
m/10 NaCl	+ .003 volt
m/10 NaHO	+ .009 volt
m/100 NaHO	+ .041 volt
m/1,000 NaHO	+ .085 volt
m/10,000 NaHO	+ .125 volt
m/100 NaHO	+ .042 volt
m/1,000 NaHO	+ .085 volt
m/100 NaHO	+ .044 volt
m/10,000 HCl	+ .126 volt
m/1,000 HCl	+ .064 volt
m/100 HCl	+ .021 volt

The *m*/10 NaHO and the *m*/100 HCl act as if they had a slight etching effect on the skin, otherwise we notice the same influence of dilution as in the case of salts.

7. We believe that these and other experiments, which will be published in the full report, show that the influence of the concentration of electrolytes on the E.M.F. of living organs agrees quantitatively with the values to be expected if the skin is permeable for

kations, impermeable or less permeable for anions.

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THE PERMEABILITY OF THE OVARIAN EGG-MEMBRANES OF THE FOWL

I

VERY ordinary eggs have long been the subject of very much noise-making; the cackling hen, the cold-storage man, and the public each playing in this an individual, different and discordant part. One wonders therefore whether the quiet of the earth might be in any measure restored if *ordinary* eggs were made different; particularly if the egg were so much metamorphosed as to be born in a fully preserved and stable state. Would the noisily expressed solicitude of the persevering egg-maker then abate? Would the cold-storage man then "fold his tent like the Arabs, and as silently steal away"? Would the voiceful public then wait with less impatience "for its ships to come from sea"?

With something of this thought—of possibly contributing a modicum to the quiet of our planet—the undersigned, in an odd moment, set to the present task many months ago. Despite the generally rough exterior of the common barn-yard fowl, is it not possible to bring about some very nice adjustments between its blood and its growing ova, such as will effect the formation of eggs thus capable of maintaining themselves against the ravages of time and the decomposing influences of temperature?

To some veteran doubters, however, it may seem that the triumph of the experiment would bring no blessings whatever; and some there may be who would even assert that its success and utilization really but spells new calamity to egg-users. We do not know; we repose in our innocent intentions, in our wonder, and in our questions.

II

Can hexamethylentetramine leave the blood and penetrate the cells which guard the germ—the germ-plasm? Supposing that it can do so, will this substance decompose spontaneously within the egg—as it is known to do in some tissues—setting free formaldehyde? And will not the formaldehyde thus liberated exercise a preserving action on the elements of the egg? Again, can sodium benzoate pass through the egg-envelopes and enter the growing egg? If so, will it do duty as a preservative there? What will sodium salicylate do in a similar way?

The answer to these questions in so far as it is supplied by our experiments may be given at once; the details and the evidence being presented later.

When hexamethylentetramine (urotropin) is fed to laying hens it passes through the follicular and vitelline membranes surrounding the egg and is deposited in the egg. It undergoes decomposition there; formalin being set free. It acts as a preservative; *i. e.*, it lengthens the time which normally intervenes between the fresh and the unpalatable egg.

Numerous chemical tests have failed to demonstrate the presence of either benzoate or salicylate in eggs from birds fed with these substances. Whether the latter actually entered the egg, but in another form or combination, *e. g.*, as hippuric and salicyluric acids respectively, has not been determined; our supply of eggs having been exhausted in making other tests. Quite probably the benzoate would give rise to ornithuric acid, since it is known that this acid is formed when benzoate is excreted through the kidneys of birds. Some other evidence, however, is afforded by the eggs from birds fed with sodium benzoate and sodium salicylate that such eggs, particularly those supposed to contain salicylate, withstand the effects of summer temperatures better than do the untreated control eggs.

III

Something is intimated above as to reasons for the expectation that the feeding of urotropin to birds would result in its penetration and preservation of the growing egg. A

further word of similar effect may be stated concerning the benzoate and the salicylate. It seemed reasonable to expect that these substances would enter the egg, not only because there is a pronounced tendency of ring- and other compounds to appear in the egg, as my own previous, though unpublished, studies have taught me, but because it was known that these substances are normally not broken down, *i. e.*, not completely oxidized in the body, and even appear in other secretions than the urine; benzoic acid, for example, having been recovered from the saliva of dogs; and the salicylate likewise from milk, perspiration, bile and from synovial sacs.

If these substances should appear in the egg it seemed reasonable to expect them to exercise a preserving action there, since it is known that they retard both peptic and tryptic digestion; putrefaction of protein solutions being retarded or entirely prevented by the presence, even in small quantities, of these compounds.

The experiments were carried out in the following manner: Normally fed, laying hens were arranged in lots of five each. To one lot urotropin was fed; to another sodium benzoate, and to another sodium salicylate. The feedings were continued over a period of eight to ten days. All of the eggs laid during the week preceding the beginning of the dosing period, and all laid during the *second* week after the close of that period, were kept as control (those laid during the first week after the dosing stopped were discarded as being contaminated with the drug).

The dosage in each case was 0.4 G. administered in gelatin capsules twice per day; *i. e.*, the total dosage during each twenty-four hours was four-fifths of a gram. Two birds were not in good condition on the fifth day of the dosing and were withdrawn from the experiment.

Both control and dosed eggs were kept at moderate temperatures, *i. e.*, 12°–18° C., until the last of the control eggs were laid. Then all were placed at a temperature which fluctuated from 20°–32° C.; being left thus exposed for months in order to compare the "keeping" qualities of the various eggs.

It is probably best to follow more specifically the eggs from the birds which were fed urotropin, since in these the experiment was the most successful. The eggs of the series were laid between June 30 and July 30. They belong, therefore, to the class of difficult-to-keep, summer eggs which cold-storage men designate as "dirties." Already on August 20 and on September 17 a comparison by taste and smell of control and dosed eggs left no doubt whatever that the dosed eggs were the more palatable. These tests repeated on October 12 and November 10 confirmed the earlier result. On the latter dates the control eggs almost without exception were quite unpalatable. The dosed eggs could be eaten even on the last named date. It can not be said, however, that these control eggs would ever be mistaken for really fresh eggs; nor that the consistency of the white or albumen was quite unchanged, for after a time the albumen of some of these eggs becomes rather more dense and elastic than is natural.

When tested for formaldehyde, by the Rimini and other tests, the eggs of this series yielded abundant quantities. Indeed it was found that such eggs were spontaneously giving off formaldehyde in quantities sufficient to be absorbed by, and detected in, some *control* eggs left in the same box. To my friend Professor Hugh McGuigan, of the Northwestern University Medical School, who is extensively studying the action and disposition of hexamethylentetramine in mammals, I am indebted for verifying these tests as well as for friendly and helpful conversations and suggestions.

It was made certain that the urotropin is excreted into both the white and the yolk of the egg. This was determined in the following manner: Eggs which were laid within twenty-four hours of a *first* feeding with urotropin were found to yield formaldehyde. Here the formaldehyde could not have entered the *yolk* while in the ovary, since such yolk must have left the ovary several hours before the feeding. It must, therefore, have

been excreted by the oviduct into, or with, the albumen. In the other case it was shown that urotropin can penetrate the follicular membrane and enter directly into the egg-yolk, since an egg which was laid five days after the *last* feeding with urotropin gave the test for formaldehyde. Two other eggs were laid by the same hen—two and four days previously—so that the above-mentioned egg could not have obtained its formalin from albumen stored in the oviduct. In this egg, therefore, only the yolk had been exposed to urotropin, and it only could have been the source of the formalin. Two other eggs of very similar history also gave positive tests for the presence of formalin in the yolk.

The eggs dosed with salicylate,[1] and less markedly those dosed with benzoate, besides appearing—somewhat inconstantly—to be better preserved, as judged by taste and smell, often showed certain other physical contrasts with the control eggs. For example, the yolks of the control eggs more often showed "adhesions" to the shell than did the dosed eggs. Of fifteen control eggs opened on October 12 and November 10, nine showed adhesions either to shell or to the membrane of the air cavity; whereas on the same dates ten eggs dosed with salicylate and eight dosed with benzoate furnished altogether only three adhesions. Too, the control eggs usually contained the more liquid albumen; a difference readily observed. Finally, it was often noted that there was present in the dosed eggs more of the dense whitish albumen of the chalazæ than in the control.

Obviously all these physical differences strengthen the not very conclusive evidence of taste and smell, that the eggs dosed with salicylate and benzoate had not undergone digestion and putrefaction to as great an extent as the normal untreated eggs.

Larger doses of these substances would probably yield more striking results. Doses of 0.2 G. of sodium benzoate were, however, occasionally seen to be regurgitated by pigeons.

[1] I am indebted to Mr. Valentine Petzold, an obliging poultryman of Chicago, for the privilige of dosing five of his birds with sodium salicylate.

I do not believe that any part of either of these drugs was so disposed of by the fowls. Actively laying hens—as these were—might withstand considerably larger amounts. Too, still other substances can doubtless be found which will yield as good or better results when applied by this method. But these questions and others are left to the labor of those who may be interested in the practical or economic possibilities of the matter.

Oscar Riddle

Laboratory of
Experimental Therapeutics,
University of Chicago

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

The American Association for the Advancement of Science and the national scientific societies named below will meet at Washington, D. C., during convocation week, beginning on December 27, 1911.

American Association for the Advancement of Science.—President, Professor Charles E. Bessey, University of Nebraska; retiring president, Professor A. A. Michelson, University of Chicago; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.

Section A—Mathematics and Astronomy.—Vice-president, Professor Edwin B. Frost, Yerkes Observatory; secretary, Professor George A. Miller, University of Illinois, Urbana, Ill.

Section B—Physics.—Vice-president, Professor Robert A. Millikan, University of Chicago; secretary, Professor A. D. Cole, Ohio State University, Columbus, Ohio.

Section C—Chemistry.—Vice-president, Frank K. Cameron, U. S. Department of Agriculture; secretary, Professor C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D—Mechanical Science and Engineering.—Vice-president, President Chas. S. Howe, Case School of Applied Science; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E—Geology and Geography.—Vice-president, Professor Bohumil Shimek, State University of Iowa; secretary, Dr. F. P. Gulliver, Norwich, Conn.

Section F—Zoology.—Vice-president, Professor Henry F. Nachtrieb, University of Michigan; sec-

retary, Professor Maurice A. Bigelow, Teachers College, Columbia University, New York City.

Section G—Botany.—Vice-president, Professor Frederick C. Newcombe, University of Michigan; secretary, Professor Henry G. Cowles, University of Chicago, Chicago, Ill.

Section H—Anthropology and Psychology.—Vice-president, Professor George T. Ladd, Yale University; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor William T. Porter, Harvard Medical School; secretary, Professor George T. Kemp, 8 West 25th St., Baltimore, Md.

Section I—Social and Economic Science.—Vice-president, Professor J. Pease Norton, Yale University; secretary, Seymour C. Loomis, 69 Church St., New Haven, Conn.

Section L—Education.—Vice-president, Professor Edward L. Thorndike, Teachers College, Columbia University; secretary, Professor C. Riborg Mann, University of Chicago, Chicago, Ill.

The Astronomical and Astrophysical Society of America.—December 27–29. President, Professor E. C. Pickering, Harvard College Observatory; secretary, Professor W. J. Hussey, University of Michigan, Ann Arbor, Mich.

The American Federation of Teachers of the Mathematical and the Natural Sciences.—December 27–28. President, Professor C. R. Mann, University of Chicago; secretary, Eugene Randolph Smith, Polytechnic Preparatory School, Brooklyn, N. Y.

The American Chemical Society.—December 27–30. President, Professor Alexander Smith, Columbia University; secretary, Professor Charles L. Parsons, Durham, N. H.

The American Society of Biological Chemists.—(Baltimore and Washington.) December 27–29. President, Professor Lafayette B. Mendel, Yale University; secretary, Professor A. N. Richards, University of Pennsylvania, Philadelphia, Pa.

The Society of American Bacteriologists.—December 27–29. President, Professor F. P. Gorham, Brown University; secretary, Charles E. Marshall, East Lansing, Mich.

The American Physiological Society.—(Baltimore and Washington.) December 26–29. President, Dr. S. J. Meltzer, Rockefeller Institute for Medical Research, New York City; secretary, Professor A. J. Carlson, University of Chicago, Chicago, Ill.

The Geological Society of America.—December 27–29. President, Professor William Morris Davis, Harvard University; secretary, Dr. Edmund Otis Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—December 28–30. President, Professor Ralph S. Tarr, Cornell University; secretary, Professor Albert Perry Brigham, Hamilton, N. Y.

The Paleontological Society.—December 28–30. President, Professor William B. Scott, Princeton University; secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

The Entomological Society of America.—December 26–27. President, Professor Herbert Osborn, Ohio State University; secretary, Professor Alexander D. MacGillivray, University of Illinois, Urbana, Ill.

The American Association of Economic Entomologists.—December 27–29. President, Professor F. L. Washburn, St. Anthony Park, Minn.; secretary, A. F. Burgess, Melrose Highlands, Mass.

The American Microscopical Society.—December 29. President, Dr. A. E. Hertzler, 402 Argyle Building, Kansas City, Mo.; secretary, T. W. Galloway, Decatur, Ill.

The Botanical Society of America.—December 26–29. President, Professor William G. Farlow, Harvard University; secretary, Dr. George T. Moore, Botanical Garden, St. Louis, Mo.

The Society for Horticultural Science.—December 29. President, Professor S. A. Beach, Ames, Ia.; secretary, C. P. Close, College Park, Md.

The American Phytopathological Society.—December 27–29. President, Professor A. D. Selby, Wooster, Ohio; secretary, Dr. C. L. Shear, Department of Agriculture, Washington, D. C.

The American Nature-Study Society.—December 27–28. President, Professor Benjamin M. Davis, Miami University; secretary, Dr. Elliot R. Downing, University of Chicago, Chicago, Ill.

The Sullivant Moss Society.—December 28. President, Dr. Alexander W. Evans, Yale University; secretary, Mrs. Annie Morrill Smith, 78 Orange Street, Brooklyn, N. Y.

The American Fern Society.—December 29. President, Dr. Philip Dowell, Port Richmond, N. Y.; secretary, L. S. Hopkins, Peabody High School, Pittsburgh, Pa.

The American Anthropological Association.—December 27–30. President, Dr. J. Walter Fewkes, Bureau of Ethnology; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-Lore Society.—December 28. President, Professor Henry M. Belden, University of Missouri, Columbia, Mo.; secretary, Dr. Charles Peabody, Peabody Museum, Cambridge, Mass.

The American Psychological Association.—December 27–29. President, Professor Carl E. Seashore, University of Iowa; secretary, W. Van Dyke Bingham, Dartmouth College, Hanover, N. H.

The Southern Society for Philosophy and Psychology.—December 28–29. President Dr. S. I. Franz, Government Hospital for the Insane, Washington, D. C.; secretary, Professor R. M. Ogden, University of Tennessee, Knoxville, Tenn.

The American Economic Association.—December 27–30. President, Professor Henry W. Farnam, Yale University; secretary, Professor T. N. Carver, Harvard University, Cambridge, Mass.

The American Statistical Association.—December 27–30. President, Frederick L. Hoffman, Newark, N. J.; secretary, Carroll W. Doten, 491 Boylston Street, Boston, Mass.

The American Sociological Society.—December 27–30. President, Professor Franklin H. Giddings, Columbia University; secretary, Professor A. A. Tenney, Columbia University, New York City.

The American Civic Alliance.—December 29. President, Dr. John Franklin Crowell, 44 Broad St., New York City; secretary, Dr. Gerald van Casteel, 80 Wall St., New York City.

The American Association for Labor Legislation.—December 28–30. President, Professor Henry R. Seager, Columbia University; secretary, Dr. John B. Andrews, Metropolitan Tower, New York City.

The American Home Economics Association.—December 27–30. President, Miss Isabel Bevier, University of Illinois; secretary, Benjamin R. Andrews, Teachers College, Columbia University, New York City.

PRINCETON, N. J.

The American Society of Naturalists.—December 28. President, Professor H. S. Jennings, The Johns Hopkins University; secretary, Professor Charles R. Stockard, Cornell Medical School, New York City.

The American Society of Zoologists.—December 27–29. President, Professor H. V. Wilson, University of North Carolina; secretary, Dr. Raymond Pearl, Maine Agricultural Experiment Station, Orono, Me.

The Association of American Anatomists.—December 27–29. President, Professor George A. Piersol, University of Pennsylvania; secretary, Professor G. Carl Huber, 1330 Hill Street, Ann Arbor, Mich.

NEW YORK CITY

The American Mathematical Society.—December 27–28. President, Professor H. B. Fine, Princeton University; secretary, Professor F. N. Cole, 501 West 116th Street, New York City.

SOCIETIES AND ACADEMIES

THE NEW YORK ACADEMY OF SCIENCES

SECTION OF BIOLOGY

A REGULAR meeting of the Section of Biology was held at the American Museum of Natural History, October 16, 1911, Chairman Frederic A. Lucas presiding. The program consisted of a lecture by Dr. Charles H. Townsend, director of the New York Aquarium, on "The Voyage of the *Albatross* to the Gulf of California."

In the spring of 1911 the *Albatross*, under the direction of Dr. Townsend, made a natural history survey of the Gulf of California. Much valuable information was obtained bearing on the oceanography and the general biology of this region, and especially the deep-sea forms.

After stating that the American Museum of Natural History, the New York Zoological Society, the New York Botanic Museum and the United States National Museum cooperated in the voyage of the *Albatross* by special arrangement with the U. S. Bureau of Fisheries, Dr. Townsend gave a general account of the work done.

The *Albatross* sailed from San Diego. Twenty-six hauls of the dredge were made, the deepest being 1,760 fathoms. Shore work was carried on at 32 anchorages around the peninsula of Lower California and at islands in the gulf. Important collections of mammals, birds, reptiles and plants were made. A special study was made of the fishery resources of the region. An interesting feature of the expedition was the rediscovery of the supposed extinct elephant seal (*Mirounga*). About 100 of these animals were found at Guadeloupe Island, which is uninhabited. Six yearlings were sent alive to the New York Aquarium, and three large males and a female were secured for skins and skeletons. The males were each 16 feet long. Excellent photographs were made. Among the interesting forms obtained by dredging were *Harriotta* and *Cyema*, two deep-sea fishes not previously recorded from the Pacific.

At the regular monthly meeting of the section held at the American Museum of Natural History, November 13, 1911, Chairman Frederic A. Lucas presiding, the following papers were read:

Further Notes on the Evolution of Paired Fins: W. K. Gregory.

The problem under consideration is a phase of vertebrate phylogeny and should be studied in connection with this larger problem.

In very early acquiring myotomes the ancestral vertebrates gained a means of locomotion, by lateral flexures of the body, that was more efficient than movement by means of ciliated epidermis.

The earliest vertebrates probably fed on microscopic particles obtained by ciliary ingestion. The Upper Silurian *Birkenia* of Traquair apparently had no biting jaws and may have sucked in small food particles, like the larval lamprey. Well-preserved material showed that none of the Ostracoderms had cartilage jaws or teeth, but the dermal plaques around the oral hood sometimes functioned as jaws. Typically carnivorous habits, involving true cartilage jaws, true teeth and both paired and median fins, are first known in the Acanthodian sharks, of the Upper Silurian and Devonian. In brief, fins of all kinds, conditioned in their first appearance by the presence of myotomes, were evolved as an incident in the general transformation of acraniate minute forms, with ciliary ingestion, into well-cephalized fishes of carnivorous habits. The speaker reviewed the evidence for the "fin-fold" theory in the different groups and stated some apparently new objections to the "gill arch" theory. He cited evidence tending to show that the various paddle-like types of paired fins with widely protruded basal cartilages, had evolved from fin-folds independently in the sharks, Crossopterygians and Dipnoans.

Notes on a Pheasant Expedition to Asia: C. William Beebe.

Mr. Beebe gave a short talk, illustrated with lantern slides, on the recent trip which he and Mrs. Beebe made around the world in search of material for a monograph of the Phasianidæ. This expedition was made under the auspices of the New York Zoological Society and at the suggestion and by the financial support of Col. Anthony R. Kuser. In the short time at his disposal he was able to touch only upon Ceylon and the Himalayas. In Ceylon the jungle-fowl peculiar to the island and the India peafowl were studied and their nests and eggs found, and in the Himalayas every genus of pheasant was investigated, from *Gennæus melanonotus* at six thousand feet, to *Ithaginis cruentus* at an elevation of fourteen thousand feet.

The three most important points brought out were the tremendous economic importance of this group, our ignorance of their ecology, and the rapidity of their extermination.

The following nominations were made for officers of the Section of Biology for 1912:

Vice-president of the New York Academy of Sciences, and chairman of the section, Dr. Frederic A. Lucas (renominated).

Secretary of the section, Dr. William K. Gregory, American Museum of Natural History.

L. Hussakof,
Secretary

American Museum of Natural History

THE TORREY BOTANICAL CLUB

The meeting of October 25, 1911, was held in the museum building of the New York Botanical Garden at 3:30 P.M., Vice-president Barnhart presiding.

The scientific program consisted of informal reports on the summer's work. Dr. N. L. Britton discussed the genus *Cameraria* L. and illustrated his remarks by specimens and illustrations of the known species, together with those of an undescribed one found by him at the United States Naval Station, Guantanamo, Cuba. He also remarked on the large number of undescribed species of plants in many genera contained in the recent Cuban collections of the New York Botanical Garden.

Dr. Marshall A. Howe gave a brief résumé of a paper on "Some Marine Algæ of Lower California, Mexico," which had been accepted for publication in the November number of the *Bulletin*. The algæ of Lower California have been hitherto almost unknown, only seven species having been attributed to the region. The materials on which the present paper was based give evidence of the existence there of at least thirty-four species, a good proportion of them being new to science, and it seems probable that adequate exploration of the region would show its algal flora to be rich and varied.

Dr. J. K. Small gave some brief notes on certain species of *Peperomia*, and Dr. H. M. Richards outlined some research work on acidity in cacti, which he had been prosecuting at the Desert Laboratory, Tucson, Arizona.

Fred J. Seaver,
Secretary pro tem.

SCIENCE

Friday, December 29, 1911

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

RECENT PROGRESS IN SPECTROSCOPIC METHODS[1]

An observer who for the first time views the light of the sun through a prism can not fail to express his wonder and delight at the gorgeous display of colors into which the white light is separated—and if the observation is made under the same conditions as in the celebrated experiment of Newton, 1666, there is in truth nothing else which he could observe. You will remember that he allowed a beam of sunlight to stream through a round opening in a shutter of his window, falling on a glass prism, which bent the sun rays through different amounts depending on their color, thus spreading out the white round sunlit spot on the opposite wall into a colored band—the spectrum—which he rather arbitrarily divided into seven colors—red, orange, yellow, green, blue, indigo and violet. (If the division were made to-day I doubt if indigo would be included.) There is in fact no definite demarcation between these, and they shade insensibly into each other—and if the solar spectrum were always produced under these conditions we should say it was continuous, indeed if it were not the sun but an argand burner or an incandescent lamp which served as source, it would really be so.

But even if the source consisted of isolated (but sufficiently numerous) separate colors, the fact would be disguised by the overlapping of the successive images. In other words the spectrum is not pure. In

[1] Address of the president, Washington meeting, December, 1911.

order to prevent this overlapping, two important modifications must be made in Newton's arrangement. First the light must be allowed to pass through a very *narrow aperture,* and second, a sharp *image* of this aperture must be formed by a lens or mirror.

The first improvement was introduced by Wollaston in 1802, who writes:

> If a beam of daylight be admitted into a dark room by a *crevice* 1/20 of an inch broad and received by the eye at a distance of 10 or 12 feet through a prism of flint glass held near the eye, the beam is seen to be separated into the four colors only, red, yellowish green, blue and violet. . . . The *line* that bounds the red side of the spectrum is somewhat confused. . . . The *line* between the red and green . . . is perfectly distinct; so also are the two limits of the violet. There are other distinct lines (in the green and blue . . .).

The second improvement was effected by Fraunhofer, 1814, and by observing the light which fell from such a narrow aperture upon a prism by means of a *telescope* he discovered upward of 750 *dark lines* in the solar spectrum, and mapped their position and general character.

In recognition of the enormous importance of this discovery, these lines are always known as the Fraunhofer lines.

A minor inconvenience in Fraunhofer's arrangement lay in the fact that the slit source had to be at a considerable distance from the telescope; and this was obviated in the apparatus of Bunsen and Kirchhoff, 1860, which is essentially the same as the modern spectroscope of to-day; consisting of a slit and collimator, prism and observing (or photographic) telescope.

And on this beautifully simple device rests practically the whole science of spectroscopy, with all its wonderful applications and all the astonishing revelations of the structure and motions of the sidereal universe, and of the constitution of the atoms of matter of which it consists—nay even of the electrons of which these atoms are built!

Without the telescope it is evident that the science of spectroscopy would be as limited in its field as was the science of astronomy without the telescope. It is interesting indeed to compare the progress of the two sciences as dependent on the successive improvements in the two instruments.

Without the telescope nothing could be discovered concerning the heavenly bodies (with the exception of a few of the more evident features of the sun, the moon and the comets) except the brightness and places of the stars, and the motion of the planets—and even these could at best be very roughly determined (say to within one part in five thousand or something over a half minute of arc). Without the telescope spectroscopy would also have been limited to observations of general differences in character of radiations and absorptions, and a rough determination of the *position* of the spectral lines, with a probable error of this same order of magnitude.

In fact the *resolving power* of the eye is measured by the number of light waves in its diameter of the pupil, about 5,000, and if a double star (or a double spectral line) presents a smaller angle than 1/5,000 it is not "resolved." The resolving power of a telescope with a one inch objective would be about 100,000; so that details of the solar and lunar surfaces and of planets, nebulæ and of double stars and star groups can be distinguished whose angular distance is of the order of 1/100,000. The discs of the planets, the rings of Saturn, the moons of Jupiter, and some star groups and clusters, begin to be distinguishable. Our largest telescopes have a resolving power as high as 2,000,000, corresponding to a limit of separation of one tenth of a second.

But in order to realize the full benefit

of the telescope when used with a prism, the latter must be so large that the light which falls upon it entirely fills the object glass. The efficiency of the prism then depends on its size and on its dispersive power.

In order to form an idea of the separating or resolving power in spectroscopic observations it will be convenient to consider the Fraunhofer line *D* of the solar spectrum, or the brilliant yellow line corresponding to the radiation given out by a salted alcohol flame. This Fraunhofer recognized as a double line, and the length of the light-waves of the components are approximately .0005890 mm. and .0005896 mm. respectively. The difference is then 6/5,893 of the whole, or about 1/1,000, requiring a prism of resolving power of 1,000 to separate them. If the prism were made of flint glass with a base of 25 mm. it would just suffice to show that the line was double.

Now we know of groups of spectral lines whose components are much closer than those of sodium. For instance, the green radiation emitted by incandescent mercury vapor consists of at least six components, some of which are only a hundredth of this distance apart, and requiring therefore a resolving power of 100,000 to separate them. This means a glass prism of 100 inches, the construction of which would present formidable difficulties. These may be partially obviated by using twenty prisms of 5 inches each; but owing to optical imperfections of surfaces and of the glass, as well as the necessary loss of light by the twenty transmissions and forty reflections, such a high resolving power has not yet been realized.

The parallelism of the problems which are attacked in astronomy and in spectroscopy is illustrated in the following table. It is interesting to observe how intimately these are connected and how their solution depends on almost exactly the same kind of improvement in the observing instruments, particularly on their *resolving power;* so that not only are the older problems facilitated and their solution correspondingly accurate, but new problems before thought to be utterly beyond reach are now the subject of daily investigation.

	Astronomical	*Spectroscopic*
1.	Discovery of new stars, nebulæ and comets.	Discovery of new elements.
2.	Star positions.	Wave-length of spectral lines.
3.	Double stars and star clusters.	Double lines, groups and bands.
4.	Shape and size of planets and nebulæ. ? Star discs.	Distribution of light in spectral "lines."
5.	Star motions (normal to line of sight). Resolution of doubles, solar vortices, protuberances, etc.	Star motions (parallel with the line of sight). Resolution of doubles, solar vortices, protuberances, etc.
6.		Changes of character and position of lines with temperature, pressure and magnetic field.
7.	Spectroheliograph (Combination of telescope and spectroscope.)	

We must especially note that the newer problems require an enormous resolving power. In the telescope this has been accomplished partly by the construction of giant refractors and partly by enormous reflectors; and curiously enough the same double path is open to spectroscopy; for we may employ the dispersive power of refracting media or the diffractive power of reflecting media. The increasing cost and difficulty of producing large transparent and homogeneous blocks of glass have tended to limit the size and efficiency of lenses and of prisms, and these have

been more or less successfully replaced, the former by mirrors, and the latter by *diffraction gratings.*

These are made by ruling very fine lines very close together on a glass or a metal surface. The effect on the incident light is to alter its direction by an amount which varies with the wave-length—that is, with the color; and a spectrum is produced which may be observed to best advantage by precisely the same form of spectrometer, with a substitution of a grating for the prism.

The dispersion of a diffraction grating depends upon the closeness of the rulings; but the resolving power is measured by the total number of lines. It is important, therefore, to make this number as large as possible.

The first gratings made by Fraunhofer, 1821, contained but a few thousand lines and had a correspondingly low resolving power—quite sufficient, however, to separate the sodium doublet. A considerable improvement was effected by Nobert, whose gratings were used as test objects for microscopes, but these were still very imperfect as spectroscropic instruments, and it was not till Rutherfurd, of New York (1879), constructed a ruling engine with a fairly accurate screw, that gratings were furnished which compared favorably with the best prisms in existence.

With 30,000 lines (covering over 40 mm.) the theoretical resolving power would be 30,000; practically about 15,000—sufficient to separate doublets whose components were only one fifteenth as far apart as those of the sodium doublet.

An immense improvement was effected by Rowland (1881) whose gratings have been practically the only ones in service for the last thirty years. Some of them have a ruled surface of 150 mm. × 60 mm., with about 100,000 lines and can separate doublets whose distance is only one one hundredth of that of the sodium doublet, in the spectrum of the first order. In the fourth order, it should resolve lines whose distance is only one fourth as great.

Practically, however, it is doubtful if the actual resolving power is more than 100,000; the difference between the theoretical and the actual performance being due to the defect in uniformity in the spacing of the grating furrows.[2]

The splendid results obtained by Rowland enabled him to produce the magnificent atlas and tables of wave-lengths of the solar spectrum which are incomparably superior in accuracy and wealth of detail to any previous work; so that until the last decade this work has been the universally accepted standard. With these powerful aids it was possible not only to map the positions of the spectral lines with marvellous accuracy, but many lines before supposed simple were shown to be doublets or groups; and a systematic record is given of the characteristics of the individual lines, for example, whether they are intense or faint, nebulous or sharp, narrow or broad, symmetrical or unsymmetrical, reversed, etc.—characteristics which we recognize to-day as of the highest importance, as giving indications of the structure and motions of the atoms whose vibrations produce these radiations.

One of the most difficult and delicate problems of modern astronomy is the measurement of the displacement of spectral lines in consequence of the apparent change of wave-length due to "radial velocity" or motion in line of sight. This is

[2] This applies to all the Rowland gratings which have come under my notice, with the exception of one which I had the opportunity of testing at the Physical Laboratory, University of Göttingen. The resolving power of this grating was about 200,000.

known as the Doppler effect and had been well established for sound waves (a locomotive whistle appears of higher pitch when approaching and lower when receding) but it was only confirmed for light by Huggins and by Vogel in 1871, by the observation of displacements of the solar and stellar spectral lines on observing in succession the advancing and the receding limb of the sun.

It may be worth while to indicate the accuracy necessary in such measurements. The velocity of rotation of the sun's equator is approximately two kilometers per second, while the velocity of light is 300,000 kilometers per second. According to Doppler's principle the corresponding change in wave-length should be 1/150,000—a quantity too small to be "resolved" by any prism or grating then in existence. But by a sufficient number of careful micrometer measurements of the position of the middle of a given spectral line, the mean values of two such sets of measurements would show the required shift. It is clear, however, that if such radial velocities are to be determined with any considerable degree of accuracy, nothing short of the highest resolving power of the most powerful gratings should be employed.

Another extremely important application of spectroscopy to solar physics is that which in the hands of Hale and Deslandres has given us such an enormous extension of our knowledge of the tremendous activities of our central luminary.

The spectroheliograph, devised by Hale in 1889, consists of a grating spectroscope provided with two movable slits, the first in its usual position in the focus of the collimator, and the second just inside the focus of the photographic lens. A uniform motion is given to the two slits so that the former passes across the image of the solar disc, while the other exposes continually fresh portions of the photographic plate.

If the spectroscope is so adjusted that light of the wave-length of a particular bright line in a solar prominence (say one of the hydrogen or the calcium lines) passes through the spectroscope then a photograph of the prominences, or sun spots or faculæ, etc., appear on the plate. But the character of this photograph depends on the portion of the bright spectral "line" which is effective, and as the entire range of light in such a line may be only a thirtieth part of the distance between the sodium lines, it would require a resolving power of at least 100,000 to sift out the efficient radiations so that they do not overlap.

As another illustration of the importance of high resolving power in attacking new problems, let us consider the beautiful results of the investigations of Zeemann on radiation in a magnetic field. The effect we know is a separation of an originally simple radiation into three or more, with components polarized at right angles to each other. This is one of the very few cases where it is possible to actually alter the vibrations of an atom (electron) and the fact that the effect is directly calculable, as was first shown by Lorentz, has given us a very important clue to the structure and motions of the atoms themselves.

The experiment is made by placing the source of radiation (any incandescent gas or vapor) between the poles of a powerful electromagnet and examining the light spectroscopically. Now this experiment had been tried long before by Faraday but the spectroscopic appliances at his disposal were entirely inadequate for the purpose.

Even in the original discovery of Zeemann only a broadening of the spectral line was observed, but no actual separation. In fact, the distance between components which had to be observed was of the order of a hundredth of the distance between the sodium lines, and in order to effect a clear separation and still more to

make precise measurements of its amount, requires a higher resolving power than was furnished by the most powerful gratings then in existence.

As a final illustration, let us consider the structure of the spectral "lines" themselves. Rowland's exquisite maps had shown many of these which were then thought simple, to be double, triple or multiple, and there are clear indications that even the simpler lines showed differences in width, in sharpness and in symmetry. But the general problem of the distribution of light within spectral lines had scarcely been touched. Here also the total "width" of the line is of the order of one one-hundredth of the distance between the sodium lines and it is evident that without more powerful appliances further progress in this direction was hopeless.

Enough has been said to show clearly that these modern problems were such as to tax to the utmost the powers of the best spectroscopes and the experimental skill of the most experienced investigators.

Some twenty years ago a method was devised which, though somewhat laborious and indirect, gave promise of furnishing a method of attack for all these problems, far more powerful than that of the diffraction grating.

Essentially, the extremely simple apparatus which is called the interferometer consists of two plane glass plates. These can be made accurately parallel and their distance apart can be varied at will. When light is reflected from the surfaces which face each other, the two reflected beams of light waves "interfere" in such a way as to add to each other, giving bright maxima, or to annul each other's effect, producing dark spaces between.

The alternations of light and darkness which occur when the eye observes in the direction of the normal are very marked so long as the plates are very near together —but as this distance increases, the interferences become less and less distinct until at a distance *which depends on the character of the incident light* they vanish completely. A perfectly definite relation holds between the "visibility curve" and the character of the radiation so that the one can be deduced from the other.

Now the "resolving power" of such an apparatus is measured by the number of light waves in the doubled distance between the surfaces. This is about 100,000 for a distance of one inch; but the distance is in fact *unlimited* and as the instrument itself is practically free from errors of any sort, its resolving power is practically unlimited.

The use of this method of light wave analysis is attended with certain difficulties, and the results obtained are not always free from uncertainties; but in view of the fact that at this time no other methods of this power had been devised, it has amply proved its usefulness. Among the results achieved by it may be mentioned: the resolution of many lines supposed single into doublets, quadruplets, etc.; the measurement of their distances apart; the distribution of light in the components; the measurement of their width and the changes produced in them by temperature, pressure, and presence of a magnetic field.

Among the radiations thus examined one proved to be so nearly homogeneous that over two hundred thousand interference bands could still be observed. Otherwise expressed, the exact number of light waves in a given distance, say ten centimeters, could always be determined; and by a comparison with the standard meter the absolute wave-length of this radiation could be measured and made to serve as a basis for all wave-lengths.

The standard of length itself, the standard meter, is defined as the distance between two lines on a metal bar; and notwithstanding all the care taken in its manufacture and preservation, there is no assurance that it is not undergoing a constant slow change, doubtless very small, but appreciable by the refinements of modern metrological methods, if there were any fundamental unchangeable standard with which it could be compared. The earth's circumference was supposed to be such a standard and the meter was originally defined as the millionth part of an earth-quadrant; but the various measurements of this quadrant varied so much that the idea was abandoned. The attempt to base the standard on the length of a seconds-pendulum was no more successful.

But we have now the means of comparing the standard meter with the length of a light wave (the standard meter contains 1,553,163 waves of the red radiation from cadmium vapor) so that should the present standard be lost or destroyed, or should it vary in length in the course of years, its original value can be recovered so accurately that no microscope could detect the difference. True it is that in the course of millions of years the properties of the atoms which emit these radiations and the medium which propagates them may change—but probably by that time the human race will have lost interest in the problem.

The difficulties in the application of the interferometer method of investigating the problems of spectroscopy, it must be admitted, were so serious that it was highly desirable that other instruments should be devised in which these difficulties were avoided. This need was supplied by the "echelon," an instrument based on the same principle as the diffraction grating, but consisting of a pile of glass plates of exactly equal thickness and forming a kind of stairs, whence its name.

The grating acts by assembling light-waves whose successive wave trains are retarded by some *small* whole number of waves (usually less than six, the distance between the grating spaces being about six light-waves), whereas this retardation in the echelon is many thousand.

But the resolving power depends on the *total* retardation of the extreme rays, and this may be made very large, either by having an enormous number of elements with small retardations—or by a comparatively small number of elements with large retardations. For example, an echelon of thirty plates of glass one inch thick, each producing a retardation of 25,000 waves, would have a resolving power 750,000—about seven times that of the grating; and this high value has actually been realized in practise.

Simultaneously Perot and Fabry showed that by the repeated reflections between two silvered surfaces[3] a very high resolving power is obtained, and a few years later Lummer devised the plate interferometer which embodies practically the same idea.

The resolving power of all of these newer devices is clearly many times as great as that of the grating—but all equally share the objection which holds (but to a far less extent) for the grating, that the different succeeding spectra overlap. It is true that this difficulty may be overcome (though with some loss of simplicity and considerable loss of light) by employing auxiliary prisms, gratings, echelons, etc., and in this form all these modern instruments have contributed results of far reaching importance, and which would have been impossible with the older instruments.

[3] Boulouch, 1893, had observed that Na rings were doubled both by reflection (grazing incidence) and transmission (normal incidence) with a light silver film.

The diffraction grating possesses so many advantages in simplicity and convenience of manipulation that it is even now used in preference to these modern instruments, save for such refinements as require an exceptionally high resolving power. But has the resolving power of the grating been pushed to the limit? We have seen that this depends on the number of rulings; and it is certainly possible to increase this number. But the theoretical value is only reached if the rulings are very accurately spaced; for instance, the resolving power of the Rowland grating is only one third of its theoretical value. This is a direct consequence of inaccuracies in the spacing of the lines. If a grating could be constructed of say 250,000 lines with exact spacing, the resolving power would be equal to that of the most powerful echelon. The problem of the construction of such gratings has occupied my attention for some years; and while it has met with some formidable difficulties, it has had a fair measure of success and gives promise of still better results in the near future.

The essential organ in all ruling engines in actual use is the screw which moves the optical surface to be ruled through equal places of the order of a five hundredth to one thousandth of a millimeter at each stroke; and the principal difficulty in the construction of the machine is to make the screw and its mounting so accurate that the errors are small compared with a thousandth of a millimeter.

This is accomplished by a long and tedious process of grinding and testing which is the more difficult the longer the screw. A screw long enough to rule a 2-inch grating could be prepared in a few weeks. Rowland's screw, which rules 6-inch gratings, required two years or more—and a screw which is to rule a grating 15 inches wide should be expected to take a much longer time, and in fact, some ten years have been thus occupied.[4]

I may be permitted to state a few of the difficulties encountered in this work—some of which would doubtless have been diminished if my predecessors in the field had been more communicative.

First, is the exasperating slowness of the process of grinding and testing the screw. This can not be hurried, either by grinding at greater speed, or by using any but the very finest grade of grinding material. The former would cause unequal expansions of the screw by heating; and the latter would soon wear down the threads till nothing would be left of the original form.

Secondly, in ruling a large grating, which may take eight to ten days, the ruling diamond (which must be selected and mounted with great care) has to trace a furrow several miles long in a surface as hard as steel—and often breaks down when the grating is half finished. The work can not be continued with a new diamond and must be rejected and a new grating begun.

Thirdly, the slightest yielding or lost motion in any of the parts—screw, nut, carriage or grating, or of the mechanism for moving the ruling diamond—is at once evidenced by a corresponding defect in the grating. When after weeks or sometimes months of preparation all seems in readiness to begin ruling, the diamond point gives way and as much time may have to be spent in trying out a new diamond.

When the accumulation of difficulties has seemed insurmountable, a perfect grating is produced, the problem is considered solved, and the event celebrated

[4] A method of ruling gratings accurately, which is independent of any mechanical device, is now in process of trial, in which the spacing is regulated by direct comparison with the light-waves from some homogeneous source such as the red radiations of cadmium.

with much rejoicing, only to find the next trial a failure. In fact, more time has been lost through such premature exhibitions of docility than in all the frank declarations of stubborn opposition!

One comes to regard the machine as having a personality—I had almost said a feminine personality—requiring humoring, coaxing, cajoling—even threatening! But finally one realizes that the personality is that of an alert and skilful player in an intricate but fascinating game—who will take immediate advantage of the mistakes of his opponent, who "springs" the most disconcerting surprises, who never leaves any result to chance—but who nevertheless plays fair—in strict accordance with the rules of the game. These rules he knows and makes no allowance if you do not. When *you* learn them and play accordingly, the game progresses as it should.

As an illustration of the measure of success attained in this work, I would call attention to a recent comparison by Messrs. Gale and Lemon of the performance of a grating of 6½-inch ruled surface with that of the echelon, the Perot and Fabry interferometer and the Lummer plate. The test object is the green radiation from incandescent mercury vapor. The spectrum of this radiation had been supposed a simple line, until the interferometer showed it to be made up of five or more components. The whole group occupies a space about one fifteenth of that which separates the sodium lines.

The grating clearly separates six components while the more recently devised instruments give from six to nine. Two of these components are at a distance apart of only one hundred and fiftieth of the distance between the sodium lines, and these are so widely separated by the grating that it would be possible to distinguish doublets of one half to one third this value; so that the actual resolving power is from 300,000 to 400,000—of the same order, therefore, as that of the echelon.

It may well be asked why it is necessary to go any further. The same question was put some twenty years ago when Rowland first astonished the scientific world with resolving powers of 100,000—and it was his belief that the width of the spectral lines themselves was so great that no further "resolution" was possible. But it has been abundantly shown that this estimate proved in error, and we now know that there are problems whose solution depends on the use of resolving powers of at least a million, and others are in sight which will require ten million for their accurate solution, and it is safe to say that the supply will meet the demand.

To return to our comparison of the telescope and the spectroscope; while the progress of investigation of the stellar universe will be ever furthered by increased size and resolving power of the telescope, this is very seriously hampered by the turbulence of the many miles of atmosphere through which the observations must be made. But there is no corresponding limit to the effective power of spectroscopes and the solution of the corresponding problems of the sub-atomic structures and motions of this ultra-microscopic universe may be confidently awaited in the near future.

The message we receive from the depth of the stellar firmament or from the electric arcs of our laboratories, come they in a millionth of a second or in hundreds of light years, are faithful records of events of profound significance to the race. They come to us in cipher—in a language we are only beginning to understand.

Our present duty is to make it possible to receive and to record such messages. When the time comes for a Kepler and a Newton to translate them we may expect

marvels which will require the utmost powers of our intellect to grasp.

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AMERICAN SOCIETY OF NATURALISTS

HEREDITY AND PERSONALITY[1]

The fathers of the American Society of Naturalists in their wisdom made the president's address an after dinner speech. What can they have meant by that, save to free him from the shackles of that rigorously scientific procedure which marks our day-light program, to enable him to speak in lighter vein, to discourse of things that as a technical scientist he can not touch; in short, to invite him to leave the solid ground of science, and, following the modern vogue, circle about a bit in the atmosphere above?

And so, in accordance with their prudent provision, I shall neither present to you results of my own experimentation, nor indulge in that favorite present-day pastime of geneticists, so facile when one is far from the material itself, of demonstrating that the experiments of some one else prove just the opposite of what he supposed them to prove. There lacks, alas! no opportunity for disputation in that part of genetics where I am at work, but the problem of pure lines and selection has been at this meeting of the society in more competent hands than my own, and it now needs, not more argument or exposition, but further investigations that shall fulfil the demands of both sides—the analytical experimentation of the pure line worker, the analytical computation of the statistical school—till the two come to some unified result.

So, turning aside from all this, I shall put forth some reflections on the relation of our knowledge of genetics to certain human problems. We ourselves are samples of the material whose rules of action we seek in studying genetics, and one can't help thinking of the bearing of the rules we discover on some of the more intimate questions of human life—even though these reflections may lead nowhere and justify no practical conclusions. Considerations of such a sort are forbidden ground to the man of science in his technical rôle; yet the human being, even though he has been through the scientific mill, is attracted by the forbidden, particularly as an after dinner diversion. We spend our time searching for the practical applications of genetics; it may be a rest from the strain to dally a few moments with the unpractical aspects. I judge that it is clear that what I have to say will have no relation to eugenics.

Genetics is that part of science which deals with the question of how living things have come to be what they are, and with what is to become of them later. Now, these are questions that have long troubled the minds of the living things that make up mankind, with relation to themselves. Shall we lay ourselves open to the charge of audacity, of presumption, even of impiety, if then we try to bring the problems of the origin and fate of human individuals into relation with the science of genetics? Following the admonition of America's philosopher, that we shall do what we are afraid to do, let us venture.

It is popularly held that in the last twenty years genetics has begun to be a science. We seem at last to have gotten hold of some of the threads by which the web unravels, and if the unraveling has not yet gone far, we at least see that the process works; that we make progress at it. It is perhaps no longer an adequate statement of our knowledge to say, as a French author did some years ago:

[1] Presidential address before the American Society of Naturalists, December 28, 1911.

Heredity is a vain word. There are in it no laws to be drawn forth, and consequently no principles that can be stated. There are simply certain curious remarks that may be made, sometimes for, sometimes against, the transmission of virtues and vices by blood. And there are no more cases for than against.

Perhaps we may say that two chief things have been discovered. One is that there is a certain permanency of type in living things, along with a certain dissectibility, as it were, and a capacity for recombination in diverse ways. Certain traits or characters seem to crystallize out, and such crystallized units hold together, and may be moved about, in the processes of generation, according to certain rules, from one individual to another, and combined with other crystals from a diverse source. Or, to change the figure, we find the living world to be a web or net of definite, relatively permanent strands, that interweave, that unite and separate, a given strand passing now into one individual, now into another; each individual presenting a new combination of the strands; a new knot in the web. And we have worked out certain of the rules according to which this interweaving takes place.

The second great discovery is that of some of the intimate material processes of this interweaving. So far as we have gone, we find that the strands which appear in one view as personal characteristics, physical or mental, appear in another as material processes, visible under the microscope; and the rules for the interweaving that we discover by the study of one aspect of the web we find faithfully followed when we study the other aspect. This correspondence seems to that unscientific wondering individual which every man of science conceals, one of the most astounding things in science; it illustrates again the artless ingenuousness of the popular idea that matter is something simple and well known, and that we deprive a phenomenon of its wonder by showing that it takes place in matter. What happens in the personal world finds its parallel, so far as we can see, in the happenings of matter; the wonder of the event is not increased or diminished whether we must call its medium matter or something else equally mysterious and unfathomable; for nothing could be more so.

Our experimental science of genetics is a physiology of the processes by which new generations are produced, comparable to the physiology of metabolism—rather than a study or doctrine of evolution; although we believe, and perhaps we see, that a knowledge of it must precede any correct understanding of evolution. Indeed, the direct attacks hitherto made on the problem of how evolution occurs seem to owe their relative lack of success to the fact that they were not based on a knowledge of the normal physiology of generation; to obtain this preliminary knowledge is now the immediate task of investigation. But this gives us as yet little or nothing that is final on how the strands that make up the living web arise, how they get their unity and permanence, and how they are transformed. Selection, mutation, environmental action, formation of developmental habits—each of these stands before us with a question mark so large as to overshadow the word itself; experimentation finds it equally difficult to confirm any of them.

But the existence and interweaving, according to rules, of these relatively permanent strands, are what remain to us positively. What is the relation of these things to our own existence and personality?

As a material, potentially visible organism, I, like the infusorian, have been in existence ever since the race that devel-

oped into human kind began. And this, for each of us, is not a figure of speech, but the plain literal truth. An unlimited microscopist could have followed with his eyes my course, and your course, down through countless ages, never losing sight of the material organism for an instant, just as our colleague, Dr. Woodruff, follows day by day his thousands of generations of *Paramecium*. I was in actual material existence as a living organism, and indeed thousands or millions of years old, when the pyramids were built, and my unlimited microscopist could give my history from that time to this without a break. What marks has that long history left on my personality and character?

When in England for the first time last summer, I was struck with the familiarity of things strange; by a feeling as if I had returned to my old home. The great things of England seem the working out, the carrying to a limit, as it were, of the tastes that live in me and mine, while the great things of other countries are the revelation of a spirit to me relatively new and foreign. It may not have been an explanation, but it was the truth when I said to myself at that time: I have indeed lived in England many hundred years, much longer than I have lived in America. During the thousands of years of my existence I have had experience of many lands and many people. But of the last thousand years of my life, I have spent all but a couple of centuries or so in England. During that time I have taken part in the growth and development of many an Englishman, and of many an Englishwoman. And who can say that what I have grown into in America has not been partly determined by those habits of growth and development that I acquired in that pleasant English country—so that it is small wonder if things there fit me as if they and I were made together?

True, I was but a cell in the bodies of those many Englishmen, but are we sure that that statement has any real meaning; that the cell—even the germ cell—is in any sense a separate thing from the remainder of the body? Must we not rather conceive the body as a unit, in which all parts share in the developmental processes that occur? In those activities of organisms that are most readily studied, the principle holds that any process gone through repeatedly and under stimulation later takes place more readily and without the original stimulus. There is no reason why we should not expect this principle to hold in development as well as in the other activities of living things. If the body develops as a unit and each cell in the body takes part in that development, we have the basis required for the operation of this principle. After it has developed in a certain way a number of times under the action of certain environmental stimuli, a piece of the body, forming the germ cell, would later develop in the same way without the same stimuli. What we have been accustomed to develop into for the last several thousand years, under the stimulus of our old homes in Europe, possibly we develop into here, so that our old homes fit us as a mold fits the candle that was shaped in it.

The gradual formation of developmental habits seems the only form of the idea of inheritance of acquired characters that is not opposed by any of the experimental facts, that helps us to understand why so many acquired characters are not inherited—since they are not produced by the developmental processes of the organism; that fits all the recent cases which give positive evidence for the inheritance of acquired characters, and that is based

on a law actually known to hold for those organic processes that are most favorable for study with relation to such laws. Can a stronger statement be made for the efficiency of selection or of any other factor, as producing and modifying the characteristics of organisms? There was a time, not distant, when the biologist hardly dared speak of the possibility of the inheritance of acquired characters in any sense, because experimentation was unable to demonstrate its occurrence. But after learning the rules for the interweaving and transfer of characteristics in successive generations, we find as much difficulty in showing experimentally that selection modifies hereditary characters as we do in showing the inheritance of acquired developmental habits, so that the two ideas now stand once more on the same footing. This revolutionary change in the relation of these two possible factors is one of the important fruits of the recent development of genetic science, with its demonstration that most of what had been considered a productive action of selection was in reality not such. If we are reduced once more to judging the two ideas by their relative value for explaining what we find to exist, habit formation in development does not suffer by comparison with selection.

If the formation of developmental habits really occurs, then the fact that each of us has taken part in the development of so many men and so many women, and even, in former times, in the development of so many creatures not yet men and women, helps us to understand many of our impulses, revealed suddenly and unexpectedly to ourselves; helps us realize why we feel that the character and tastes we have manifested in our lives form only one of the types of character that we might have displayed; that perhaps we have displayed in times past.

But however it be with this particular point, I have lived, like the infusorian, in unbroken material continuity for uncounted ages; if the phrase "potential immortality" means anything for the infusorian, it means exactly the same for me, so far as we can judge from past history.

But what then of the future? We have each a singular wish to trace our existence not so much backward as forward; certainly no other problem of genetics has commanded such universal interest as that of immortality.

Many non-scientific theories of immortality have held that we do continue to exist in later generations, in the form of human beings or in other forms, but that we do not remember our previous lives. This last proviso is a relapse into science; it is an attempt to reckon with the facts, for we each observe, upon inspection, that we do not remember a previous existence.

What difference would there be between reincarnation without recollection of our previous experiences—and the actual reliving of our characteristics when a portion of our body develops anew the character and traits that now exist in us? If *you* are a reincarnation of some former individual without the remembrance of his experience—and *I* am a re-development of the characteristics of some former individual from a piece of his body—what pragmatic difference, what difference that experiment or experience could detect, would there be between the two cases?

Thus the fact that we re-live in posterity would seem to constitute all that can be meant by immortality without recollection—if we reproduced as the infusorian does, each for himself, each giving rise to individuals like himself.

But just here we meet that tremendous

complication, which confuses the mind on this point, as it does on so many others. How relatively simple a science would biology be, and how totally different from what it is, if there were no intermingling of individuals for reproduction! The next re-development of *me* is not merely myself—my characteristics, but a combination of my characteristics with those of some one else. And not all of my characters go into the new generation, but only a part of them. And still more perplexing, what I contribute to this new generation often turns out not to be my personal characteristics at all, but those of various and sundry other persons scattered along the line down which I have come, and for which I have served merely as a storehouse, without my knowledge or consent.

And in fact, it turns out that *I* have been merely a sort of focus or knot, in which a lot of strands have been tied together—strands that diverge before and behind me. Cut the knot—the strands separate, scatter and unite with others. Those in my knot have come from a hundred others, and may later unite in a hundred still diverse. Of my characteristics I may say, like Iago of his purse "'twas mine, 'tis his, and has been slave to thousands." Only the scattered parts of me will continue to exist, in diverse persons. And so much is already true; my component parts exist at this moment in many persons now alive, so that if the continued existence of my scattered parts is what we must mean by immortality, then such immortality is the lot of all; it holds as well and in the same sense for him who leaves no children of his own as for the parent. The conclusion of the whole matter, from this point of view, can be only that humanity is but a single organism, merely temporarily separated into pieces, which later reunite, and that we personally must console ourselves (if it is a consolation) with the realization that our characteristics exist elsewhere in humanity and will continue to exist after that particular knot which forms the present self has been untied.

But has not our point of view thus far been after all inadequate for sounding the real depths of our problem? It omits the deepest of all the difficulties; the fact that *I*, the ego, as a feeling, experiencing, knowing self, am identified with only one of these knots into which the living strands are tied; my experiences cling to that one alone. Was it the small boy Huxley (or was it some other one of the famous precocious youngsters that fulfilled their promise) who asked his mother whether she was not overwhelmed by the consciousness of her own identity? And isn't that the most extraordinary of all things, that my experience, embracing in its grasp the universe, is tied down in relations of identity to a single one of the millions of knots tied in this web of strands that have come down from the unbeginning past? For an observer standing to one side, as it were, it is not difficult to comprehend that different combinations of strands should give different characteristics; different personalities in that sense. But that the observer himself—my total possibility of experience, that without which the universe for me would be non-existent—that this should be given only by one particular combination is hard to conceive.

It is the problem of distribution that here seems to call for analysis. Through the operation of what determining causes is my self—my entire possibility of experiencing this wonderful universe—tied to this particular one of the combinations of strands, rather than to some of the mil-

lions of others? And would *I* never have been, would *I* have lost my chance to participate in experience, would the universe never have existed for me, if this combination had not been made?

There seem to be certain facts that bear upon this question. My self, my personal identity, has as a matter of fact arisen in connection with a particular union of two germ cells each bearing a certain combination of the strands that determine characteristics. The essential question is: Could any other combination have produced *my* personal identity?

We find that other combinations are formed in great number, but that none of these do as a matter of fact produce *my* self, not even when they are combinations of germ cells from the same two parents. Suppose that my particular combination of germ cells had never been made, then seemingly those other combinations that *are* made would produce the same results that they now produce, namely, individuals that are *not-I*. And my personal possibility of experience would have been forever non-existent!

On this basis, what are the chances that *I* should ever have existed; that the particular combination which produced *me* should ever have been made? According to competent authorities, one of the two preexisting combinations from which my combination was derived possessed somewhat more than 17,000 germ cells, while the other produced the very considerable number of 339 billions of germ cells. So far as conditioned by the characteristics of these germ cells, any one of the 300 billions might have united with any one of the 17,000; any combination was *a priori* as probable as any other, and the chance that my particular combination should have been formed was therefore but one in five millions of billions![2] Gentlemen, I must congratulate myself on my fortune in being with you this evening!

But this gives but a minute fraction of the real odds against my existence, or your existence, if each of us depends on the occurrence of some particular combination of the strands. We have taken my two parents and their union as given. But the chances were equally many thousands of billions to one against the existence of each of them, and even existing, they might have mated otherwise, absolutely precluding the possibility of that combination to which my identity and experience are attached; and if we go back many generations, applying as we must the same considerations, we see that the system of notation which humanity has devised would be quite inadequate to express the odds against the formation of the combination from which I was derived, or you were derived. The chances were infinite against my existence and your existence.

As an abstract mathematical proposition, you may, if you like, decline to be impressed with this, because the chances were just as strong against the existence of any other persons, and yet some were bound to exist; you and I were therefore just as probable as any one else. While this reasoning is abstractly just, it fails to be entirely satisfying to the self when it is my total possibility of existence that is disposed of in this light way. But this and all our reasoning thus far omits the essen-

[2] If we choose to take into the computation out of the 17,000 ovules only the 400 that actually mature, the chance for any particular combination is one in 120 thousand billions. After reaching the thousand billions, cancellation of a factor of a few hundreds or thousands ceases to produce an impressive difference. The figures here given for the numbers of germ cells are from the "American Text-book of Physiology," 1901, Vol. II., pp. 444 and 454.

tial point, the real tragedy of the situation. If each diverse combination produces a different *self,* then there existed in the two parents the potentialities—nay, the actual beginnings—of thousands of billions of *selves,* of personalities, each as distinct as you and I. Each of these existed in a form as real as your existence and my existence before our component germ cells had united. And of these thousands of billions, but four or five have come to fruition. What has become of the others? A thousand earths might have been populated with those personalities now consigned to limbo. Or, if, as before, we include in our thought other persons, and previous generations, what must we conclude? A real infinity of potential, of inchoate, selves, is cancelled in each generation; a potential and inchoate population sufficient to people all the regions that mythology has invented; all the worlds that astronomy has discovered.

Our instincts and our education impel us to regard a human personality as the highest and most real of entities, having attributes of worth possessed by nothing else; perhaps as being sacred and imperishable. What are we to say of this infinite number of personalities whose existence was foreshadowed and prepared in exactly the way that gave origin to you and to me; who depended only on a chance meeting of germ cells for their full fruition, yet that never advanced farther?

It has become popular, with the advance of the theory of natural selection, to shudder at the tragical ruthlessness of nature, because, according to the very moderate estimate of the poet,

> of fifty seeds
> she often brings but one to bear.

Many a plant produces thousands of spores for each one that matures, and many a fish produces thousands of eggs condemned to premature destruction. Natural selection has therefore been reproached as a tragic and cruel method of advance, since out of the thousands of inchoate existences it brings but one to fruition. An honored former president of this society has tried to show us that nature acts in a kindlier way, through an attempted demonstration that natural selection is not the correct theory as to the method of advance of living things.[3] But the destruction of the uncounted millions was not a part of the theory; it is an observed fact, for which the theory merely tried to give some sort of an excuse. If no purpose is served, no advance made, through this wholesale slaughter, then mere wanton cruelty is substituted for that cruelty whose aim is kindness. But whether with an aim or without, we find that nature plays in the same infinitely wasteful and cruel way, whether with spores of fungi and eggs of fish, or with the potencies and beginnings of human personalities; it is but one out of billions prepared that comes to fruition.

It is not strange that with the instincts and education which we have, men should turn away from such a view of nature, and should attempt to find some alternative that does not lead to such monstrous results. If we have, from studies in philosophy or in other fields, reached the conclusion that the self is the one certain reality, that relation to its existence is the final touchstone for all knowledge; that it is the highest and greatest thing; that it is as it were self-existent, perhaps even imperishable—then this conviction will appear to us a sound argument against the correctness of a view of nature which shows us the existing human selves as a mere chance

[3] Morgan, T. H., *The Popular Science Monthly,* May, 1905, p. 63.

remnant saved from an infinite slaughter. There exists, as we know, an alternative point of view in regard to human selves; one not reached by following the road that leads from the facts of biological science; one that gives the human self a very different position and relation to the rest of the universe. Is that indeed a real "view" or is it a mere refusal to look at the view which is before us? Is that viewpoint one that could be reached in any way from the biological field? Is there any possibility of reconciling it with the data with which we have been dealing? Can we possibly give our own argument a different direction?

With some ingenuity one might find a parting of the ways at that point in our argument where it was set forth that if *I* did not exist, all the other combinations of germ cells that are made would still produce the same result that they do produce —namely, individuals that are not-*I*, so that I would never have existed. It could perhaps be maintained that, on the contrary, *my* existence is in some way one of the determining factors for what shall be produced by other combinations, so that if I did not already exist, some of those combinations might produce a different result from what they do produce; that they might indeed in that case produce *my* self. Granting this, I might have had my personal existence as a self, in connection with some different combination of the living strands, in case the one I am tied to had not been formed.

To work this out in detail, one would apparently have to hold that the human self is an entity existing independently of the living material, and that it merely enters at times into relations with one of the knots of the living web. If one particular combination or knot should not be produced, it would enter into another. Thus each of us might have existed with quite different characteristics from those which we have; it would be only our specific characteristics that were determined by the chance combinations that happened to be made, not our total existence as a self.

We have recently witnessed the phenomenon of a vice-presidential address before a section of the British Association for the Advancement of Science, which set forth that the facts of physiology suggest the existence of an entity or soul that is essentially independent of the body, merely acting through it.[4] Could not those aspects of genetics to which we have called attention be readily converted, likewise, into an argument, convincing for those already convinced, for the independent existence of the self or soul? The monstrous results to which the straight-forward consideration of the data leads us could be held to demonstrate in themselves that we had gone astray; that at the parting of the ways we must follow the other road, leading to views in harmony with our convictions drawn from other fields. Neglecting all difficult details as to when and how and why the temporary union of self and the body is made—how simple and satisfactory to hold (if you can) that there is a limited store of selves ready to play their part; that the mere existence of two germ cells which may (or may not) unite has no determining value for the existence of these selves, but merely furnishes a substratum to which for mysterious reasons they may become temporarily attached; and that therefore there is no cancellation of billions of inchoate human personalities, such as the other view leads to; that nature does not deal with human selves as with spores

[4] Macdonald, J. S., *Nature*, September 14, 1911, pp. 364–365.

of fungi, or as with an infinitely great sum of figures employed in computations amounting to trillions and quadrillions, all to be canceled save a result expressible in units. And what interesting corollaries might be drawn from such a doctrine, as to the farther independent existence of the selves after the combinations to which they are attached have been dispersed!

Certainly I do not wish to be understood as advocating this second point of view. The experiences of scientific investigation do not convert one to that thoroughgoing pragmatism which holds that satisfaction to our instincts is ground for holding a proposition to be verifiable. But I take it that the function of a scientific exposition is to follow wherever the argument leads, and when the road forks, with no sign-board to tell us positively which fork to follow, it must chronicle that fact, and investigate so far as it can the regions into which each fork leads, leaving the question of choice to each person as a person. When the man of science leaves the solid ground and takes to his aeroplane, such a rule is doubtless difficult, for all roads become dim, but it still remains the ideal.

Gentlemen of the society, whether you have followed me in any other respect or not, you will admit the truth of my introductory promise that I would give you a rest from things practical and that I would not try to lead you to any conclusion. Looking at some of the elementary facts of genetics in relation to ourselves, we saw that each of us has been in unbroken material existence for countless ages, during which time we have taken part in the upbuilding of many a brute and many a man and many a woman. After speculating a bit as to the marks which these experiences may have left on our characters, we turned our eyes to the future. We found that each of us is but a knot in a continuous web of strands that have, in other combinations, built up many persons, and will, in still new combinations, build up many others. Thus, as we have before taken part in the development of brute and of man, we may hope later to take part in the development of superman. Finally we looked at the relation of some data of genetics to the problems of personal identity and the self. Here the straight path of science, when followed simply and unsuspectingly, showed us nature cutting off budding human personalities by the billion, where she brings one to fruition. Whether this ingenuous and unforeseeing pursuit of the scientific path as marked out by the objective data is the only proper method for the establishment of belief on such a point or whether we are justified in turning off at a certain juncture, because this takes us where, for other reasons, we would prefer to go, is a question which leads into broader fields than the experimental science of genetics.

H. S. Jennings

SCIENTIFIC NOTES AND NEWS

The American Association for the Advancement of Science and the national scientific societies affiliated with it are opening at Washington the tenth convocation week meeting as this issue of Science is sent to press. There are published above the presidential addresses of Professor Michelson before the American Association and of Professor Jennings before the American Society of Naturalists. These will be followed by other addresses and by the proceedings of the meetings.

Dr. K. von Goebel, professor of botany at Munich, Dr. Aurel Voss, professor of mathematics at Munich, and Dr. Ewald Hering, professor of physiology at Leipzig, have been elected knights of the Bavarian Maximilian order for art and science.

PROFESSOR W. C. BRÖGGER (Christiania), Professor T. Curtius (Berlin), Professor P. A. Guye (Geneva) and Professor H. Rubens (Berlin) have been elected honorary members of the Royal Institution.

PROFESSOR WALDEYER, of Berlin, has been elected president of the International Committee of the forthcoming International Congress of Medicine, in the room of the late Dr. Pavy.

PROFESSOR JOHN F. HAYFORD, director of the College of Engineering, Northwestern University, has been appointed by the chief justice of the United States a member of a commission of engineers to obtain the data necessary to settle the boundary between Costa Rica and Panama.

The Academy of Sports of France has awarded its gold medal to Admiral Peary for the "admirable lesson of physical energy and moral courage that you have given to the entire world in the midst of fatigues, sufferings and difficulties, the conquest of the North Pole." The resolution was moved by Dr. Charcot.

A $1,000 industrial fellowship has been given the College of Agriculture of the University of Wisconsin for the purpose of studying pea diseases with a view to their prevention. R. E. Vaughn, a graduate of the University of Vermont in the class of 1907, has been appointed to the fellowship for the present academic year.

MR. D. T. GRISWOLD, of College Station, Texas, has accepted a position to do extension work in agriculture for the Agricultural College of Porto Rico. He will sail for Porto Rico soon.

PROFESSOR NEWSTEAD has returned from the expedition to Central Africa, on which he had been sent by the Liverpool School of Tropical Medicine in connection with the commission on sleeping sickness, which the government is sending out under Colonel Sir David Bruce.

THE chief speaker at the public exercises of Johns Hopkins Commemoration Day, on February 22, will be Dr. S. Weir Mitchell, of Philadelphia. His subject will be "George Washington."

PROFESSOR J. MCKEEN CATTELL, of Columbia University, addressed the Huxley Society of the Johns Hopkins University on December 20, his subject being "Some Problems of University Administration."

PROFESSOR CHARLES W. BROWN, of Brown University, lectured on November 25 before the Yale Geological Club on "The Human Aspects of the Jamaica (1907) Earthquake," showing how geological investigations should decide upon the location and mode of construction of buildings, and how by the cooperation of geologists and structural engineers the damage from earthquakes in most seismic regions could be almost eliminated. Professor M. L. Fernald, of the Gray Herbarium, Harvard University, lectured before the club on December 7 on "The Distribution of the Coastal Plain and Maritime Plants in North America." The great dominance of the plants of the New Jersey coastal plain in the Newfoundland flora was pointed out and its important geologic significance was emphasized. The inland distribution of maritime plants into the Mississippi valley and over the western part of the continent was also discussed. On December 8, Professor Fernald gave a lecture to the Yale Chapter of the Society of Sigma Xi on "Botanical Evidences bearing on the Exploration of the Norsemen," in which it was shown that the accounts which have been assumed by historians to show their exploration along the eastern coast of the United States did not reach in fact south of the St. Lawrence estuary.

AT a representative meeting of former students and friends of the late Professor P. G. Tait, at the University of Edinburgh, it was decided to undertake to establish an additional memorial to him in the form of an endowment of a Tait chair of mathematical physics at the University of Edinburgh.

IT is proposed to erect a statue of Joseph Priestley, at Birstall, near which he was born in 1733.

MISS SUSAN MARIA HALLOWELL, professor emeritus of botany in Wellesley College, where

she had taught since the establishment of the institution in 1875, until her retirement in 1902, has died at the age of seventy-six years.

Mr. Arthur Cottam, who, while engaged in the service of the British government, carried forward valuable work as an amateur astronomer, died on November 23, aged seventy-five years.

Dr. Giorgio Spezia, professor of mineralogy at Turin, died on November 10 at the age of sixty-nine years.

Nature states that the premises of the Institute of Chemistry, the lease of which will expire shortly, and can not be renewed, have become inadequate for the increasing activities of the institute. To carry on the work, the council of the institute requires new buildings, which should include more commodious meeting rooms, library, laboratories, examination rooms, and offices. It is proposed to begin the preparation of plans next year, and it is estimated that the necessary building and fittings will cost about 15,000 *l*. An appeal has been made to fellows and associates of the institute, which has already resulted in the receipt of contributions and promises amounting to more than 8,000 *l*.

A bill (H. R. 14,120) has been introduced in the House of Representatives by Congressman J. Hampton Moore, which calls for an appropriation of $80,000 to enable the Secretary of Agriculture, in cooperation with the various state authorities, to take necessary measures for checking the chestnut tree blight. Of this amount, $20,000 is to be immediately available, and $10,000 is to be spent in studying the relations of insects to the disease. A bill carrying essentially the same provisions (S. 3,557) has been introduced in the Senate by Senator Penrose.

Representatives of the Imperial Health Office, of the medical faculties and a number of journalists met on December 20 at the Ministry of the Interior at Berlin and organized a committee with the object of promoting German participation in the fifteenth International Congress on Hygiene and Demography to be held at Washington in September, 1912.

The Medical Record states that the American Association for the Conservation of Vision is inaugurating a wide-spread campaign of public education to call the attention of people to the care and preservation of their eyesight. The association has recently moved to new offices at 105 East Twenty-second street, New York City. A recent election of officers leaves the personnel as follows: *President*, Dr. F. Park Lewis; *Vice-President*, E. L. Elliott; *Acting Secretary*, Douglas C. McMurtrie; *Acting Treasurer*, T. Commerford Martin. Dr. Hiram Woods, of Baltimore, is on the board of managers and Dr. G. E. de Schweinitz, of Philadelphia, is director of the Department of Diseases and Defects of the Eye. Among the publications of the association are its *Bulletin* and *Monograph Series*, the first of a popular and the latter of a technical nature. The first issue of the *Bulletin* is entitled "Conserving Vision," compiled by Douglas C. McMurtrie and edited by G. E. de Schweinitz, M.D., F. Park Lewis, M.D., Louis Bell, Ph.D., and E. Leavenworth Elliott. The first issue of the *Monograph Series*, edited by Douglas C. McMurtrie, is entitled "Ophthalmia Neonatorum in Ten Massachusetts Cities" by Henry Copley Greene. The association has now in press additional booklets of a popular nature.

The state school fund of Wisconsin will soon be distributed to the various school districts of the state. The per capita apportionment for persons of school age is $2.783, as compared with $2.423 last year. It is a surprising fact that there are 6,236 fewer persons of school age reported for the year ending June 30, 1911, than for the year ending June 30, 1910. The loss in the number of persons of school age is pretty well distributed over the state. Excluding cities under city superintendents, only 24 of the 71 counties show a gain. The increase ranges from 614 for Clark County to 3 for Langdale County. Of the 68 cities under city superintendents 38 show a gain in school population, the largest gain, 767, being in Milwaukee.

A correspondent calls attention to the fact that *Nature* says: "It is proposed to establish

a post of demonstrator in medical etymology in connection with the Quick Laboratory. The appointment will be made by the Quick professor of biology." He suggests that the Slow professor of philology may some day appoint a demonstrator of oriental entomology.

Carnegie University, at Wilmington, Del., states in its announcement that it is "the oldest and most celebrated institution of learning of its kind in the United States of America" and that "by virtue of the powers invested in the university by the government of the state of Delaware" it confers numerous degrees, including M.A., Ph.D., Sc.D., M.D., LL.D., etc. A member of the staff of the *Journal* of the American Medical Association wrote that he was unable to take the regular course, but would pass the examination if the university would send him the examination papers. Among the questions and the answers submitted were the following:

Question—What is histology?

Answer—Histology is the study of the history of the anatomy and physiology of the body.

Question—What is embryology?

Answer—Embryology is the study of the newborn baby and how to care for it.

Question—Describe the portal circulation.

Answer—The portal circulation is the circulation of the chyle and chyme which is found in the stomach when the food is being digested. It then goes into the blood to build up the body.

Question—Describe the fornix.

Answer—The fornix is that part of the throat at the back of the tonsils which is affected in catarrh. An adjustment of the vertebra of the neck will often help it.

Question—How would you replace a dislocated lower jaw?

Answer—The jaw should be pulled forward or pushed back, as the case may be, and the joint massaged and adjusted.

Question—Give pathology, etiology, symptoms and treatment for malaria.

Answer—Malaria is found in the south and in swampy places. The patient should be given massage to make the bowels move and the spine should be adjusted to improve the circulation. It is also better to have the patient move from a malarial place to where it is dry.

The action of the "University" was given in a letter which begins:

We herewith have the pleasure to inform you that you have passed your examination very satisfactorily, and that the Carnegie University has conferred on you the degree of Doctor of Mechano-Therapy. The diploma will be forwarded to you on receipt of post-office money order of $50.

A course of sixteen lectures on economic agriculture is offered at Columbia University, beginning with an introductory lecture on Wednesday, November 22, 1911, at 4:30 P.M., and continuing on successive Wednesdays (except from December 20 to January 3 inclusive). These lectures, while dealing with the scientific aspects of the subjects announced in the course, will be divested as much as possible of technicalities. The program is as follows:

November 22—"How a City Man can Succeed in Farming," Professor O. S. Morgan, Columbia University.

November 29—"Agricultural Possibilities about New York City," Mr. George T. Powell.

December 6—"Soil Bacteria—their Importance and How to Control them Advantageously," Director Jacob T. Lipman, New Jersey Agricultural Experiment Station.

December 13—"Practical Problems in Developing the Dairy Herd," Professor Henry Wing, Cornell University.

January 10—"Corn Growing in the East," Director Thomas F. Hunt, Pennsylvania State College of Agriculture.

January 17—"The Farmer as a Plant Breeder," Hon. W. N. Hays, assistant secretary of agriculture.

January 24—"Problems in Feeding the Dairy Herd," Professor E. S. Savage, Cornell University.

January 31—"Poultry Raising," Dr. Raymond Pearl, State Agricultural Experiment Station, Orono, Maine.

February 7—"Soil Drainage Problems and Practises in New York State," Professor E. O. Fippin, Cornell University.

February 14—"Fundamental Problems in Maintaining Soil Fertility," Dr. O. Schreiner, Bureau of Soils.

February 21—"Truck Farming and its Prob-

lems near Great Cities,'' Professor R. L. Watts, Pennsylvania State College of Agriculture.

February 28—''Peach Orchards,'' Professor M. A. Blake, New Jersey Agricultural Experiment Station.

March 6—''Planting an Orchard,'' Dr. U. P. Hendrick, Agricultural Experiment Station, Geneva, N. Y.

March 13—''Orchard Management—with special reference to Fertilization and Spraying,'' Dr. J. P. Stewart, Pennsylvania State College.

March 20—''Problems in Eastern Farming.'' Lecturer announced later.

March 27—''Practical Considerations in Farm Management,'' Dr. W. J. Spillman, Bureau of Plant Industry.

THE following lectures on zoological subjects will be given at Trinity College during the course of this year.

December 15—Raymond C. Osburn, acting director of the New York Aquarium and associate professor of zoology, Columbia: Fishes.

January—Frederic S. Lee, director of the department of physiology, College of Physicians and Surgeons, New York: Some Aspects of Muscle Action.

February—George H. Parker, professor of zoology, Harvard: Some Phases of the Nervous System.

March—Professor Henry A. Perkins, Trinity: The Brownian Movement of Ultramicroscopic Particles.

May—Dr. David Dwight Whitney, of Wesleyan: Some Problems in Sex.

April—Irving A. Field, United States Bureau of Fisheries: Utilization of hitherto unused Fishes as Food.

THE faculty of Medicine of Harvard University offers a course of free public lectures, to be given at the Medical School, Longwood Avenue, Boston, on Sunday afternoons, beginning January 7, and ending May 5, 1912. The lectures will begin at four o'clock and the doors will be closed at five minutes past the hour.

January 7—Dr. F. C. Shattuck: Catching Cold, etc.

January 14—Dr. John Lovett Morse: Feeding of Infants.

January 21—Dr. Myles Standish: The Care of the Eyes.

January 28—Dr. S. B. Wolbach: A Medical Expedition to West Africa.

February 4—Dr. Abner Post: Syphilitic Heredity.

February 11—Dr. E. E. Southard: The Mental Life in the Light of Modern Efforts to Map the Brain.

February 18—Dr. Charles S. Minot: The Human Face.

February 25—Dr. Joel E. Goldthwait: The Effect of Posture upon the General Efficiency of the Human Being.

March 3—Dr. C. P. Putnam: The Care and Training of Children.

March 10—Dr. Maurice H. Richardson: Conservation, not Destruction, the Chief Object of Surgical Endeavor.

March 17—Dr. Charles J. White: Possibilities of Infection of the Skin in Public Places.

March 24—Dr. E. H. Bradford: Some Causes of Backache.

March 31—Dr. George Burgess Magrath: The Massachusetts System of Medico-legal Inquiry.

April 7—Dr. Charles M. Green: Certain Topics in the Hygiene of Women. (To women only.)

April 14—Dr. E. H. Nichols: The Sexual Instinct—Its Abuse and Control. (To men only.)

April 21—Dr. John Bapst Blake: Fractures, Sprains and Minor Injuries: Diagnosis and Treatment. (Illustrated by lantern slides.)

April 28—Dr. George T. Tuttle: Some Forms of Mental Disease and the Methods now employed in their Treatment.

May 5—Dr. C. J. Blake: The Prevention of Unnecessary Noise.

THE home universities committee of the Congress of the Universities of the British Empire, consisting of the vice-chancellors of the universities of the United Kingdom and other representatives, have prepared the program of subjects for discussion at the congress in July, 1912. The meetings of the congress will be held on July 2, 3, 4 and 5, on four mornings and two afternoons. There will be, in addition, a business meeting. The subjects for discussion fall under two heads, and are as follows:

I. Universities in their relation to one another:

1. Conditions of entrance to universities and the possibility of equivalence and mutual recognition of entrance tests to degree courses.

2. Interchange of university teachers; conditions of interchange.

3. Interuniversity arrangements for post-graduate and research students.

4. Question of division of work and specialization among universities.

5. The establishment of a central university bureau; its constitution and functions.

II. Universities in their constitutional aspects and in their relation to teachers, graduates and students:

1. The relation of universities to technical and professional education and to education for the public services.

2. Provision of courses of study and examinations for other than degree students, including university extension and tutorial class work, and specialized courses both of a general and technical character for students engaged in professional, commercial and industrial pursuits.

3. The representation of teachers and graduates on the governing body of a university.

4. Action of universities in relation to the after-careers of their students.

5. The position of women in universities.

6. The problem of universities in the East in regard to their influence on character and moral ideals.

7. Residential facilities, including colleges and hostels.

THE "Quarterly Return of Marriages, Births and Deaths," published by the authority of the registrar-general and abstracted in the London *Times*, shows a remarkable decline in the "natural increase" in population in England and Wales by excess of births over deaths. During the three months there were only 81,645 more births than deaths as compared with 123,300, 124,054 and 123,022 in the third quarter of 1908, 1909 and 1910, respectively. The births registered in the third quarter of 1911 numbered 222,601 and were in the proportion of 24.4 annually per 1,000 of the population, which is 2.9 per 1,000 below the mean birth-rate in the ten preceding third quarters, and it is the lowest birth-rate recorded in any third quarter since the establishment of civil registration. In registration counties with populations exceeding 100,000, the lowest birth-rates during the quarter were 18.4 in Sussex, 20.0 in Northamptonshire, 20.1 in Berkshire, 20.2 in Devon, Somerset and Carnarvonshire. The highest rates were 26.7 in Northumberland, 26.8 in Carmarthenshire, 27.3 in Nottinghamshire, 27.7 in Staffordshire, 29.9 in Monmouthshire, 30.9 in Durham and 31.7 in Glamorganshire. In the 77 great towns the birth-rate averaged 25.5 per 1,000, ranging from 15.8 in Bournemouth, 16.0 in Hastings, 17.9 in Hornsey, 18.3 in Halifax, 18.5 in Huddersfield and 18.6 in Bradford, to 30.1 in Bootle, 31.3 in Stoke-on-Trent, 32.7 in Merthyr Tydfil, 34.7 in St. Helens and 35.3 in Rhondda. In the 136 smaller towns the mean birth-rate was 23.6 per 1,000, and in the remainder of England and Wales, excluding the 213 chief towns, it was also 23.6. The deaths registered in England and Wales last quarter numbered 140,956, and were in the proportion of 15.5 annually per 1,000 persons living; this rate is 1.7 per 1,000 above the mean rate in the ten preceding third quarters. In registration counties with populations exceeding 100,000, the death-rates ranged from 11.4 in Wiltshire, 11.7 in Somerset, 11.8 in Berkshire and Hertfordshire, 11.9 in Shropshire and 12.1 in Buckinghamshire, to 16.7 in the West Riding of Yorkshire, 17.5 in Glamorganshire, 17.6 in the East Riding of Yorkshire, 18.0 in Staffordshire, 18.5 in Lancashire and 18.6 in Durham. The population of the United Kingdom in the middle of 1911 is estimated at 45,311,078 persons; that of England and Wales at 36,168,750, that of Scotland at 4,766,860 and that of Ireland at 4,375,468. These estimates are based upon the numbers enumerated at the censuses of 1901 and 1911. In the United Kingdom 277,655 births and 173,105 deaths were registered in the three months ended September 30, 1911. The natural increase of population was, therefore, 104,550. The official vital statistics of France for the first six months of 1911 give a total of 385,999 birth and 404,278 deaths, being an excess of deaths of 18,279.

UNIVERSITY AND EDUCATIONAL NEWS

AT a meeting of the lumbermen of the North Idaho Forestry Association held in

Spokane on December 16 the members voted unanimously to pro-rate their timber holdings in the state of Idaho to the extent of $58,000 for the purpose of erecting a forestry building at the University of Idaho.

At its meeting on December 15 the board of regents of the University of Michigan took an important step with reference to graduate studies. Hitherto this work has been in charge of a subcommittee of the literary faculty. The recent action (1) founds a university graduate department; (2) provides for the appointment of a dean as chief executive; (3) places the direction of all matters affecting graduate studies in the hands of an executive board of seven, together with the president and dean *ex officiis*. A mixed committee, drawn partly from the administration and partly from the senate, submitted the plan as adopted, after prolonged consideration. This committee was as follows: the President; Regents Sawyer, Beal and Hubbard; Dean V. C. Vaughan, of the medical faculty; Dean John O. Reed, of the literary faculty; Professor R. M. Wenley, of the department of philosophy; Professor F. N. Scott, chairman of the present graduate council, and Professor Alexander Ziwet, of the engineering faculty.

Buildings costing nearly $1,000,000 are either being constructed or will be started at the University of Wisconsin before the next academic year opens. Nine new structures will be completed within the next twelve months on various parts of the university grounds. The new buildings and their cost will be as follows:

Biology hall	$200,000
Wing to library	165,000
Home economics building	115,000
Model high school	150,000
Women's dormitory	150,000
Agricultural chemistry	90,000
Chemistry building wing	76,000
Horticultural building	57,000
Gymnasium annex	15,000
Total	$998,000

The horticultural building is now almost completed and will be ready for classes at the opening of the second semester in February. The annex to the gymnasium will be completed about February 1. The big new biology hall, which will give the department of biology one of the finest homes at any American university, will not be completed before the end of the present school year. Last week ground was broken for three of the new buildings—the women's dormitory, the agricultural chemistry building and the new home economics building, and work will be rushed on all three of these buildings so that they may be ready for occupancy at the opening of the academic year next fall. The basements of both the wing to the chemistry building and that to the library are completed, but further work will not be resumed on them until spring. It is also understood that work on the new model high school, to be built for the use of the students at the university preparing to be teachers, will not be started until spring. This building is to be constructed on University Avenue, nearly opposite the United States Forest Products Laboratory.

The *Journal* of the American Medical Association states that a decree has been promulgated for the improvement of the scientific and clinical education in the French medical schools. Its main features are as follows: (1) the duration of the medical course is increased from four to five years; (2) practical work in physiology and medical physics and chemistry and bacteriology is to be compulsory; (3) the hospital *stage* will be coextensive with the medical course and will include the various services; (4) to decrease the effect of chance in examination, each student will have a record book in which will be noted the credits he has obtained in laboratory and chemical work and previous examinations.

Edward D. Sisson, recently head of the department of education at the University of Washington, has been appointed professor of education in the newly established Reed College, at Portland, Ore.

Mr. Fletcher McFarland has been appointed instructor in physiology at the University of Minnesota.

DISCUSSION AND CORRESPONDENCE

THE POSITIVE ION IN ELECTRICAL DISCHARGE THROUGH GASES

WHEN a metal sphere is hung upon a silk cord between the terminals of a plate glass electric machine, it will oscillate to and fro between the terminals.

When molecules of a gas are placed in a similar position, they can not behave in quite the same fashion. No one molecule can plow its way through the swarm of molecules which surround it. They are all being urged to do this. At any instant some are being urged away from the positive terminal, and some from the negative. These opposing streams of gas mingle. The collisions which result between these overcharged and undercharged molecules within such a field of force result in a continual transfer of electrical corpuscles from molecule to molecule. In such a mixture we should at any instant expect to find three classes of molecules. Those which are negatively overcharged, those which are negatively undercharged, and those which are in normal condition.

Even in open air discharge, the repelled molecules move along streamers. In particular is this the case at and near the positive terminal. Here the corpuscles and air molecules are moving in opposite directions. In rarefied gas, where the mean free path is greatly increased, these streamers become "rays."

All of the properties of these rays are in harmony with what we should expect, from our knowledge of the behavior of the metal ball and the properties of gases.

FRANCIS E. NIPHER

WASHINGTON UNIVERSITY

A NEW RECORD OF A CHESTNUT-TREE DISEASE IN MISSISSIPPI

PROFESSOR EUGENE HILGARD, of Berkeley, Cal., told me this summer of an observation of his which is of moment to those interested in the chestnut-bark disease.

While surveying in 1856 in the northeastern part of Mississippi, he found the chestnut trees of that region, both young and old, dead. They had been growing in a mixed forest of pine and oak and, as the other trees were in a healthy condition, were very noticeable. The dead trees were frequently of large proportions, attaining a height of 80 to 90 feet. When he saw them, these trees were beginning to decay; the bark was dropping off, leaving the trunks bare. There were no signs of insects. The region which was surveyed is a non-calcareous one.

As chestnuts are still growing in northeastern Mississippi, the epidemic which Professor Hilgard saw did not exterminate the tree in that region. It is another record of a devastating disease which the chestnut tree has endured.

Now that extra attention has been given to the chestnut and old records have been looked over, the struggle which this tree has had against attacks of fungi and of insects during the nineteenth century becomes apparent. There can hardly be a doubt but that the present range of this tree is much less extensive than formerly.

CAROLINE RUMBOLD

BLANDING'S TURTLE

TO THE EDITOR OF SCIENCE: Referring to Mr. Howe's note in SCIENCE of September 1, "Second Record for Blanding's Turtle in Concord, Mass.," and of the introduction of three pairs of the same species in Little Long Pond, Orange County, by Dr. Townsend, I beg leave to report finding this turtle at Queens, L. I., in June, 1909. It has been placed on the records of the Natural History Survey of Long Island now being made by the Brooklyn Institute of Arts and Sciences. This is the first report, so far as we know, of Blanding's turtle having been found on Long Island, but Abbott in "A Naturalist's Rambles about Home" mentions finding it in central New Jersey.

JOHN J. SCHOONHOVEN

THE MOTH OF THE COTTON WORM

TO THE EDITOR OF SCIENCE: In connection with the notices appearing in SCIENCE (October 16 and November 10) recording the occurrence far north of the moth of the cotton

worm (*Alabama argillacea* Hubn.), it may be worth while to place on record the fact that this insect has been very abundant in parts of the south this year. Here at least, and if one may judge from observations from a car window, in northern Alabama as well, the cotton has suffered also complete defoliation.

J. R. WATSON

FLORIDA AGRICULTURAL
EXPERIMENT STATION

TRANSPLANTATION OF OVARIES

TO THE EDITOR OF SCIENCE: May I have space in your columns to say a few final words regarding the results of transplantation of ovaries?[1]

Professor Castle has objected to my application of the term mongrel to guinea-pigs used by him in experiments which he claims overthrow my results on chickens.[2] My authority for the use of this term is the following extracts from his paper.[3]

The ovaries were removed from an albino guinea-pig and in their stead were placed two ovaries, one from each of two black guinea-pigs. The female bearing the engrafted ovaries was subsequently bred to an albino male and of the resulting six young, all were black and red, and one had a white foot. In explanation of this white foot, it is stated that "*Spotting characterized the race from which the father came. He was himself born in a litter which contained spotted young. . . .*"[4] Therefore the male was a mongrel.[5]

In the other instance, an albino female was spayed and her ovaries replaced by the ovaries of a brown-eyed cream guinea-pig. The albino female was then bred to an albino male and two albino and one brown-eyed cream offspring resulted. In attempting to explain this result, it is stated that "*albinism occurred as a recessive character in the particular brown-eyed cream stock used. . . .*"[4] So it follows that at least one of the females used in this experiment was a mongrel, and was therefore, as in the first experiment, entirely unsuited to furnish any reliable information from the standpoint of foster-mother influence.

C. C. GUTHRIE

PHYSIOLOGICAL LABORATORY,
UNIVERSITY OF PITTSBURGH

[1] SCIENCE, N. S., 1911, XXXIII.

[2] SCIENCE, N. S., 1911, XXXIII.

[3] Publication No. 144, Carnegie Institution, pp. 9–10.

[4] Italics mine.

[5] In an article by Professor Castle appearing in *The Popular Science Monthly* under date of May, 1910, it is stated that in such an experiment six young resulted and they were "*all black*" (italics mine). From the data in my hands it is impossible to conclude whether this is the same experiment as that quoted above, and to which it bears a striking similarity. If it is the identical experiment, and this I assume in view of his more recent statement (Publication No. 144, Carnegie Institution, 1911, p. 8) that but two of his successfully operated animals had borne young, the article in *The Popular Science Monthly* must be inaccurate.

MOULTING AND CHANGE OF COLOR OF COAT IN MICE

MR. C. C. LITTLE has, in a recent number of SCIENCE (October 27, 1911), taken exception to certain statements that I made in an article on the inheritance of coat colors in mice. He believes that the unusual patterns that I have described, especially in black mice, which I attributed in part to a heterogeneous condition, are only temporary effects and are due to moulting. That the coat may appear spotted at times of moulting is too familiar to any one keeping these animals to call for comment. But that the patterns that I described are not due to this was shown by the fact, stated in my paper, that the fully grown hair was in all cases studied under the microscope and the pigments in the hair recorded. Moreover, the cases described were not incidental to the coat-changing period, for the pattern remained for several months until, in fact, a new moult appeared.

It is well known that black mice contain both black and chocolate in the hair, even when they produce only black mice. Hence the opportunity is furnished for the local excess of one or of the other pigment to become apparent. That such effects are due to some "physiological conditions" present at the time of moulting is very probable, and was mentioned in my paper. Furthermore, in

a series of experiments in which black and chocolate mice were crossed through several generations, the spotting in the heterozygous mice—known to be such—was very prevalent. Finally, that even dilute colors are themselves modifiable by the condition of the animal when the next coat is formed was illustrated by some of the cases that I described, and is a phenomenon well known to breeders of animals. It is true that such cases do not show the animals to be heterozygous and therefore the presence of spots can not in itself be taken as a safe criterion of that condition. But my evidence showed that heterozygous mice frequently give evidence of their dual nature. In other cases also, as in the pomace fly, where I have found a dominant and a recessive character both present in the same individual, breeding tests have shown such individuals to be heterozygous.

T. H. MORGAN

QUOTATIONS

THE ROYAL SOCIETY

AT the anniversary meeting of the Royal Society yesterday afternoon the president made an announcement of unusual interest. On July 15 of next year the society will have been in existence for two centuries and a half; and it has been decided to celebrate the occasion in the manner prescribed by custom for such functions of retrospection and congratulation. For this particular function a new descriptive word seems necessary. It is not a jubilee, or a centenary, or a bicentenary, or a tercentenary, with all of which we have been made familiar, but something compounded of a bicentenary and a jubilee. Some compendious title seems to be required, but Sir Archibald Geikie managed to do without one, and what the Royal Society has been unable to invent it would be rash on the part of any other authority to supply. We must all be content to say that the Royal Society is going to celebrate the 250th anniversary of its foundation. The chief universities, academies, scientific societies and other institutions in this country, in the dominions and abroad are to be invited to send delegates to take part in the ceremony, of the importance of which the king, as patron of the society, has been pleased to express his appreciation. In view of the high place held by the Royal Society among the scientific institutions of the world, and of the eminent services which by universal consent it has rendered to science, there can be no doubt that the response to its invitation will be ample and generous. Next year will witness a large and brilliant gathering of men of science from every part of the civilized world, eager to testify to the respect which the long history of the Royal Society has inspired among all seekers after natural knowledge. Though the principles of the great quest are always the same, two and a half centuries bring many and profound changes in methods and conditions. Many ideas once cherished have to be dropped, and many new ones assimilated. Fundamental theories become outworn, and the most fruitful hypotheses, having served their purpose, have to give place to newer generalizations. The best proof of the vitality of the Royal Society is that it has survived all these transformations, and that it holds its place to-day, as in earlier years, in the van of the great army of students of the laws and structure of the universe.

Though the progress of science has been continuous through the long period covered by the lifetime of the Royal Society, the rate of progress has not been by any means uniform. The great intellectual upheaval of the renaissance gave a powerful impulse to scientific inquiry, after centuries of extremely slow progress. But that special impulse in turn exhausted its strength, and was followed by a period of smaller achievement. The end of the eighteenth century saw the beginning of another great era of activity, which continues to the present day in shapes that more and more conform to Bacon's contention that the pursuit of knowledge should be directed to the improvement of the conditions of human existence. Men now living have been witnesses of a great transformation, at least in

the external aspects of scientific activity. Superficially it might seem that science has lost something of its interest for the mass of the nation by the disappearance of the rather heated controversies in which men of science took part a generation or two ago. We have, for example, no controversialist like Huxley to arrest attention by a lively polemic connecting science with cherished beliefs in another sphere. But that is really evidence that science is better and more widely understood by the mass of the nation than it was in his day, and perhaps also that men of science themselves have advanced beyond a standpoint from which such a polemic appeared useful. It may even be noted that scientific thought is less concerned than it was with abstract disputation, and applies itself much more closely to more positive and practical lines of inquiry. The note of the present day is the enormous extension of applied science, and the danger is that the minute specialization such extension involves may militate against the appearance of one of the commanding intellects that from time to time have opened up a new world. It seems to some observers that some great step in advance is due for the whole scientific army, as distinguished from the mass of excellent detailed work now done upon existing lines. We have as it were a great scientific community working out the exploration of a region long ago discovered and surveyed, but there is room for some one who shall climb to the top of Pisgah, and announce to us a new land of promise which man may enter and possess. As we can not feed upon the crude elements that build up our bodies, but must depend upon plants as intermediaries, so in our manifold and voracious activities we are using up intermediate products of natural forces, the store of which is not inexhaustible, but we have not learned how to harness the natural forces themselves for our purposes—the energy of the sun, the power of the tides, and the yet unpenetrated processes by which nature, in the quietest manner, achieves results only imitated in our laboratories by enormous expenditure of stored-up energy.—London *Times*.

SCIENTIFIC BOOKS

The Voyage of the "Why Not?" in the Antarctic. The Journal of the Second French South Polar Expedition, 1908–10. By Dr. Jean Charcot. English version by Philip Walsh. Illustrated. 4to, pp. viii + 315. New York, Hodder and Stoughton.

This expedition, the second made by Dr. Charcot to the Antarctic, was not a south-polar quest, but was for scientific exploration. Fitted out by the French government at an expense of $140,000, it was aided by various subscriptions to the extent of $20,000 in money. Additional gifts and loans from learned institutions made "the scientific arsenal one of the richest and completest ever carried by a polar expedition."

> The exact object of the expedition was to study in detail, and from all points of view, as wide a stretch as possible of the Antarctic in this sector of the circle, regardless of latitude. I knew that I had chosen the region (south of Cape Horn) where ice confronts the navigator as far north as 61°, and where the coastline is fringed with high mountains, to all appearance insurmountable.

One phase connected with the expedition was unusual, illustrative as it was of that generous spirit of cooperation in scientific investigations, which to-day causes all civilized nations to interest themselves in ventures of general welfare. It was natural that French generosity should be manifest in donations for an expedition of its own government, but that other nationalities should tender material and important aid was as gratifying as it is unusual. Mr. Gordon Bennet with customary generosity filled the bunkers of the *Why Not?* at Madeira. The Prince of Monaco gave a complete oceanographical outfit. The meteorological department of the Argentine Republic loaned scientific instruments. Chili contributed seventy tons of coal. Brazil not only gave one hundred tons of coal on the outward passage, but also filled the bunkers on the return, both at Rio and at Pernambuco.

The admirable manner in which the ship did her work was due to the care, foresight and judgment exercised in planning and in building the *Why Not?*. The general equip-

ment and arrangements for scientific work were equally satisfactory, but the canned provisions either from character or from quality were unsuited to prevent scurvy. Nine of the twenty-nine members of the personnel were polar veterans, whose services were entirely satisfactory—producing a maximum of possible results.

Leaving Havre, August 15, 1908, the *Why Not?* sailed *via* Rio and Buenos Aires—in which cities great interest was shown and material aid given—to Punta Arenas, whence she departed on December 16. At Port Deception, South Shetlands, was found a steam-fleet—engaged in the renewed whaling enterprizes—from which Charcot obtained his last coal.

Favored by fine weather the *Why Not?* skirted the west coasts of Palmer and Graham Lands, making many discoveries and reaching Alexander Land. Obliged to return for winter quarters to Peterman Island, the ship grounded en route and barely escaped destruction.

After eight months in winter-quarters Charcot was able to break out, and obtaining coal at South Shetlands—to renew his explorations to the south in the summer of 1909–1910, when his success was phenomenal.

In the two summer voyages he extended this part of the continent of Antarctica from the Antarctic circle to 70° S., surveying Loubet coast, discovering and mapping Fallières Land, extending Adelaide Island from an islet to a land seventy miles long, opening Marguerite Bay, surveying Alexander I. Land, and finally discovering Charcot Land in 77° W., 70° S., a mountainous, almost ice-covered region—doubtless a part of the continent.

Keeping to the west the *Why Not?* traversed unknown areas, along the parallel of 70° S., from 103° W. to 124° W. (except on the 107th meridian where Cook passed); in latitudes from two to three hundred miles to the south of Charcot's predecessors—he sounding as he sailed.

The second voyage was made under conditions of great peril, for a survey of the *Why Not?* by a diver at South Shetlands disclosed that "The whole stem below water-line was torn away, as well as several meters of the keel: the slightest shock might send the ship to the bottom." The diver remonstrated, yet Charcot sailed.

This being a popular volume, it does not give the results of the immense amount of scientific work done, including observations on gravity, seismology, meteorology, geology, tides, magnetism, zoology and oceanography. Many attractive sidelights are, however, thrown on these subjects by the notes made from day to day. A spirit of French gaiety and good humor pervades the book, and these qualities were evidently characteristic of the party as a whole.

The generous spirit shown by Dr. Charcot in giving due credit to his predecessors adds much to the enjoyment of his narrative. Such action is in striking contrast to the unfortunate tendency of some explorers of smaller mind to mar the value of their own exploits through neglect or by disparagement of the work of others, whether associates or rivals. Especially grateful to Americans are the credits given and justice done to Palmer and Pendleton.

The volume is most creditable to the publishers, and the translation good. The illustrations are excellent, but the south-polar chart should have been on a larger scale, with side maps, and its text should have been in English. The volume will interest all readers fond of travel and exploration.

A. W. GREELY

Stereoscopisches Sehen und Messen. By von CARL PULLFRICH. Jena: Gustav Fischer. 1911. Pp. 40.

This useful pamphlet, so far as the text is concerned, is available in English as the article on the "Stereoscope" in the eleventh edition of the Encyclopedia Britannica. The pamphlet contains some supplementary statements; but its notable addition is a bibliography of 276 numbers covering the period 1900–1911. This in turn supplements the bibliography available in M. von Rohr: "Die

binokenlaren Instrumente." Both text and bibliography are concerned predominantly and designedly with the physical problems of stereoscopy, though the discussion of the resulting refinements and variations of the stereoscopic effect reflects indirectly upon the psychological problems. While involving at each step questions of psychological analysis and theory, the essential advances in stereoscopy have been physical in nature. In part they constitute the physical solutions of problems raised by the study of depth-perception; and in yet larger measure they constitute original physical problems of application, extension, and quantitative refinement of the stereoscopic principle. However, the existence of an adequate psychological study contributes to the physical problems a very different status than attached to them fifty years ago, when it was difficult to convince the scientific public that psychology had any logical right or proprietary interest in an instrument made of prisms, or lenses, or mirrors.

The renascence of interest in stereoscopic problems is abundantly evidenced by the extent of the literature, and further by the great variety of publications in physiological, psychological, ophthalmological and general scientific journals, together with applications of stereoscopic presentations to scientific, educational and technical procedure. While the expository article of Dr. Pullfrich touches upon but few of these phases of the subject, it is written with a background reference to them, as a support of the interest in the problems considered. It seems the irony of fate that the man who by construction and analysis had done so much to make possible the refinements of stereoscopic vision, is himself deprived of their enjoyment. Having lost the use of one eye, Dr. Pullfrich records that to him the beauties of stereoscopic effects are a matter of remembrance only.

Pullfrich's exposition is itself so condensed that this notice may be confined to an account of its method and procedure. The fundamental condition of stereoscopic vision is the separation and position of the eyes in the head, the variations of which in different animals offer suggestive and as yet incompletely interpreted potentialities of depth-perception. The part of the visual field in which stereoscopic vision operates is limited, and makes the reports of space-relations from those portions of the visible world which the right eye and the left eye respectively but exclusively survey, a special problem of *indirect* stereoscopy. Obviously such report is momentary and shifting, since a turn of the eyes brings the outlying object into the binocularly policed territory. As to the physiological or psychological basis of the team-work which the two eyes so marvelously perform, we are reduced to ingenious hypotheses. The principles of stereoscopic vision express merely the conditions of conformity necessary to the production of the depth-effect, and the corollaries of variation in effect resulting from shifting values of the many variable contributors. It has become clear that the presumable alternative of the earlier discussions between the part played by "retinal dissimilarity" and by "convergence shiftings," is not an exclusive one; the two jointly contribute to the effect in practise, and this circumstance reflects back upon the theory, by suggesting that tentative motor initiatives may even fuse with seemingly instantaneous retinal impressions.

The physical problems are, in a sense, conditioned by the marvelous precision of the psychological depth-perceiving mechanism; for were not the optical instrument supported by the visual fineness of distinction, there would be no possibility of the utilization by the eyes of the extensions and controls of its verdicts which the inventions of Dr. Pullfrich and the constructions of the firm of Zeiss have added to the triumphs of science. The problems arising from the reconstruction of a natural depth-effect from the combination of two photographic (or diagrammatic) views—the divergence of which reproduces the difference resulting from the base line of the interocular distance —are naturally distinct from those growing out of the project of extending the range or degree of depth-perception of an actual and

extensive three-dimensional world. The former problem was in principle solved by Wheatstone, and its perfection in securing an orthostereoscopic effect—apart from convenience and refinement—follows upon the analyses and elimination of the incidental and unintentional deviations between the optical system of the photographic reproduction, and that of the original visual experience. Invention has been fertile, especially in devices for presenting to the eyes the two divergent views, leading to such diverse pieces of viewing apparatus as the reflecting stereoscope of Wheatstone, the refracting one of Brewster, the lenticular of Helmholtz, the complementary chromatic effect of Rollman-d'Almeida, the Ives parallax stereogram, the unilateral reflecting stereoscope of Pigeon, and in another direction, to the invention of the Verant lenses; in yet another, to the devices for stereoscopic projection, and again to the study of pseudostereoscopy. The enlargement and precision of stereoscopic vision has led to the stereotelemeter, in which the projection of a scale incorporated in the optical system of the instrument (by engraved lines on the objective, or equivalent device) over the distant landscape gives accurate stereoscopic judgments at a telescopic range. Conversely the stereo-comparator provides the means of restoring to space-relations of the third dimension, the minute transverse deviations of the two divergent representations resulting from any given real (or calculated) base line. From this, in turn, other problems diverge, such as that of constructing an equally precise photographic stereo-camera, and again of restoring from the stereograms thus resulting, the actual object—say, a statue—in its three dimensional reality. No less accurately than a phonographic disc preserves a voice for posterity may a solid reproduction of our actual bodily self in length, breadth, thickness of build and feature, be embodied on the twin record of a true stereoscopic print. Finally, of applications of stereoscopic principles there are many and varied examples, from the detection of forgeries to that of the variability of stars, or examination of microscopic specimens.

Pullfrich's article is devoted not to the description or analytic aspects of the problems of which these several inventions form the solutions, but to the clear and concise statement of the physical (and mathematical) aspects of the constructions involved, with due reference to the functional service sought. For this specific purpose, as well as for a general survey of the recent advances in stereoscopy, the pamphlet may be unreservedly recommended.

JOSEPH JASTROW

De Fabricatie van Suiker uit Suikerriet op Iava. By H. C. PRINSEN GEERLIGS. Amsterdam, J. H. De Bussy. 1911. Second edition. Pp. xxiv + 500 + xx.

Desire to keep pace with the rapid advances which the art of sugar-making is constantly experiencing has induced Prinsen Geerligs, the well-known Dutch sugar-expert and author, to prepare this new edition of his book, which was originally published in 1907.

The work is divided into three sections. The first of these is given over to a consideration of the raw material and discusses the occurrence and distribution of the various constituents of the sugar-cane—sucrose, dextrose, lævulose, invert-sugar, fiber, the pectins, organic acids, cane-wax, coloring matters, nitrogenous bodies and mineral matters.

The second section is concerned with the technology of sugar-making. Attention is first given to the extraction of the juice from the cane and in this connection there are considered, sugar-mills, processes of diffusion, the treatment of bagasse and determination of its fuel-value. Then follows an exhaustive discussion of various processes of defecation and carbonatation, having for their object the clarifying of the crude cane-juice, and a detailed review of various reagents employed for the purpose.

Under the caption "Concentration of the Juice," the author deals with the preliminary concentration of sugar solutions, vacuum-pans and their accessories, and the working up of by-products.

As is well warranted by its importance, a separate chapter is devoted to the composition and utilization of molasses; Java-molasses, to the study of which the author has given much time and personal attention, receives specific consideration.

The final section of the book deals with factory-output, calculations and records; extensive tables and a satisfactory index conclude the volume.

This brief outline of the book's contents will indicate in how thorough and painstaking a manner the author has acquitted himself of his self-appointed task. His familiarity with the work of other investigators, with that of his American confrères among others, is amply attested by foot-notes and references scattered throughout the volume.

The straightforward, lucid style in which this book is written is characteristic of its author and makes its reading a pleasure, nor must the excellent make-up of the publication pass unnoticed—the quality of paper used, its typography, the marginal indices, all certainly merit the appreciation of its readers.

F. G. Wiechmann

An Introduction to the Lie Theory of One-Parameter Groups, with applications to the solution of differential equations. By Abraham Cohen, Ph.D., Associate in Mathematics, Johns Hopkins University. Boston, D. C. Heath & Co. 1911. Pp. iv + 248. Half leather.

The scope of this attractive little volume may be inferred from its seven chapter headings, which are as follows: Lie's theory of one-parameter groups, differential equations of the first order, miscellaneous theorems and geometrical applications, differential equations of the second and higher orders, linear partial differential equations of the first order, ordinary differential equations of the second order and contact transformations.

In form, binding and paper the present volume is similar to the "Elementary Treatise on Differential Equations," by the same author, published in 1906. In subject matter it forms a suitable sequel to this work, but it can be read with a more limited knowledge of differential equations. While it should appeal especially to the student of mathematics who is about to begin graduate work in an American university, it should also prove useful to those who make frequent use of the differential equation in applied fields of mathematics and who desire to look at the subject from the systematizing and clarifying standpoint of group theory.

The book closes with an appendix containing seven notes, two tables, answers to the examples, and a good index. In these notes several important subjects are developed for which there was no room in the body of the book. In particular, the n-parameter group of transformations is considered briefly in one of these notes. The two tables contain forms of differential equations of the first and of higher order which are invariant under known groups.

It is very gratifying to witness the rapid increase of American mathematical literature suitable for students who are just beginning graduate work. Even very good students of mathematics have found the transition period from undergraduate to graduate work discouragingly difficult because they were all at once compelled to use foreign literature with an abrupt change of point of view and method of presentation. During the last decade much has been done to remedy this serious drawback, but there are still many lacunas in this literature. The present volume has reduced by one the number of the most important of these.

G. A. Miller

SPECIAL ARTICLES

CARBON DIOXIDE AT HIGH PRESSURE AND THE ARTIFICIAL RIPENING OF PERSIMMONS

It is already known from the work of Prinsen-Geerligs (through Gore, 1910) on the fruit of the banana that its astringency disappears, without softening of the pulp (mesocarp), when surrounded by an atmosphere deprived of oxygen. This result suggested to

Gore, of the Bureau of Chemistry, U. S. Department of Agriculture, that the use of any "inert" gas would be equally efficient, and accordingly he tried the effect of carbon dioxide (Gore, 1910, 1911). The outcome of his experiments, as of my own (Lloyd, 1911) is to show that the results of Japanese method of processing, a procedure, apparently empirical, of exposing the fruit to the fumes of sake by packing in recently emptied casks, may be duplicated. Indeed, according to Fairchild (1905, 1911), attempts on a limited scale to imitate the Japanese method in this country, had already met with success, so that there could have been little doubt in the minds of those cognizant of the facts that, with effort, but a short time need intervene before a method could be worked out for attaining, even on a practical scale, the results desired. The expectation must have been strengthened by the results obtained by Vinson (1909) on the date (*Phœnix dactylifera*) whose fruit possesses, as regards the tannin cells, cytological characters precisely similar to those of the persimmon, sapodilla and other, doubtless numerous, fruits. Vinson found that acetic acid fumes can be used for processing dates to prepare them for the market, the immediate and important outcome being the loss of astringency. He (Vinson, 1910) further found that a host of reagents of the same phase can be used, but with attendant results undesirable from an economic point of view. Of these, for a single example, nitrous ether affects the tannin cells in such a manner that the contained tannin is no longer free to enter into solution, and hence the non-astringency. Even heat may be used to hasten the result, as Vinson (1907, 1910, 1911) also showed, while Freeman (1911) extended the use of this discovery in a practical way.

In order to describe the loss of astringency, it was stated jointly by Bigelow, Gore and Howard (1906) and later by Vinson (1907) that the tannin in the persimmon becomes "insoluble" during the ripening process. But, as I have shown, "insoluble" tannin is not otherwise known. To use the adjective quoted is to contravene the accepted definitions of the substance therewith described. Indeed, the astonishing unusualness of the conception appears when it is realized that there is known no compound of tannin with organic products, composing "leather" of one form or another, which, by repeated contact with fresh solvent, will not give up fractions of the amount of tannin originally bound up with the associated substance. Analogies in the field of colloidal chemistry will immediately occur to those even only slightly initiated into its mysteries, for such they surely are at the present moment. My own work begun on the date (1910) in 1907 and continued on the persimmon (1911, *a* and *b*) and sapodilla (1911, *b*) has enabled me to throw some light on the difficulty. I have shown that, during the process of ripening, the loss of astringency is due to the union of the tannin with an associated colloid (1911, *a*) of carbohydrate nature (1911, *b*), which is an intraprotoplastic product in common with the tannin itself, and which undergoes a gradual coagulation as seen in its increasing firmness and loss of swelling capacity. During this process the tannin becomes adsorbed, and there is thus formed a vegetable leather, from which only exceedingly small fractions may be extracted by ordinary solvents (water, alcohol), but which may be attacked chemically and then extracted by means of strong nitric acid, leaving the entire, or nearly the entire amount of the associated colloid intact (Lloyd, 1911, *c*). We may thus obtain this as yet practically unknown body for examination by chemical methods, which have already yielded some important results, indicating as above noted its carbohydrate nature.

So that it develops that the essential fact of the loss of astringency is the formation of a colloidal complex, of which tannin is one, and another carbohydrate the other member. Disregarding those reagents which have a chemical effect upon the tannin itself (so far as we can determine this) there is a number of substances which are capable of hastening this process. Alcohol and acetic acid vapors (the possible chemical effect of the latter on

tannin being disregarded for the moment) do so, but the change is accompanied by other autolytic processes, in equal rates, which cause the digestion of the middle lamella, and, probably, conversion of sugars and of aromatic substances. Carbon dioxide, however, is peculiar in that the loss of astringency is materially hastened while, relatively, the remaining changes are held in abeyance, being, however, hastened as compared with normal conditions. Herein lies the secret of the Japanese process, the source of the carbon dioxide being the fruit itself, as a result of respiration. As Gore (1910, 1911) showed, a pure atmosphere of carbon dioxide, making available a larger amount, may be used. I have repeated his experiments with the goal of immediate practicality in view, and have succeeded in perfectly processing two varieties of Japanese persimmons (*Taber 129* and *Hyakume*) in churn barrels on a scale sufficiently large to demonstrate the feasibility and low cost of the method for the grower or merchant. The mechanical features of the churn barrel (of the "Daisy" churn) permit the easy packing of the fruit in suitable material and the lid may be made sufficiently tight to imprison the carbon dioxide for the period necessary without recharging. The details of the method will appear in another form later. But this is not all, nor the most important feature of this work. I have further demonstrated that, *under increased pressure of carbon dioxid, the processing is hastened,* so that, with a pressure of 15 pounds the time required may be reduced from six to seven days, the time required under normal pressure, to less than two days. The definiteness of the experiment on this score leaves so little to be desired that I venture to detail it. Six dozen fruits, of the two varieties mentioned in nearly equal numbers, were introduced into an autoclave (The Eclipse Sterilizer) at 4 P.M., November 16. No packing was used, the fruits being placed side by side on cardboard trays. The air in the autoclave was first displaced, after which the pressure was increased to 15 pounds. A somewhat sudden lowering of the pressure from 15 to 14 pounds was attributed to the penetration of the gas into the fruit, and, at the expiration of 20 minutes, the pressure was again raised to 15 pounds. During the night, however, the pressure fell to normal, and, after recharging, the safety valve was found to leak. After adjustment the pressure remained close to 15 pounds. At 5 P.M. the same day, the pressure was raised to 18 pounds, but it fell during the night to 17 pounds, falling to 15 pounds by 2 P.M. The autoclave was then opened, and the fruit tested. The fruits examined, in all about three dozen, by various persons, were found completely processed, save that, up to date, one particularly hard and light-colored fruit was found very slightly astringent. By way of further practical test, a dish of the fruit was served to a number of guests at my home on the night of the same day, and they all found the fruit very hard, sweet and delightfully aromatic.

Fruits of the same lot, but processed two weeks previously, yielded to the treatment under normal pressure in seven to eight days. The control experiment, in which fruits of the same lot were exposed to normal pressure in a churn barrel, yielded in 8 to 10 days.

It should not be overlooked that this surprisingly short period of two days may be too brief for fruit which has just been harvested, and may vary also with the time at which the harvesting takes place. In any event, however, as the control shows, the time involved will be materially shortened with increase of pressure in the amount already indicated.

The above experience leads us to infer that, if the initial pressure had been constantly maintained, the completion of the process might have been still further hastened, while it is possible that still higher pressures may be correspondingly more efficient. Setting this aside, since there are a number of questions regarding color, degree of maturity and the like, in their relations to the rate and agents of processing which must be further studied, there is no doubt that the method of making use of supranormal pressures of carbon dioxid may be employed to an advantage

superior to that of normal pressure. The somewhat increased cost necessitated by a tight receiver is more than offset by the reduced time involved, by the certainty of the results and by the immediate availability. A suitable receiver of heavy galvanized iron similar to a kind already on the market, can be manufactured at a reasonable cost.

But the practical value of this result is no greater than its theoretical bearing. It appears, in the first place, that the rôle of carbon dioxid is not associated with its inertness, but is, on the contrary, positive, a conclusion demanded, I believe, by the time relations. How this view may be harmonized by the remaining heterogeneous mass of facts, at present available through the efforts of the abovementioned workers, it is too early to say, but it will prove, I believe, a fruitful suggestion that the explanations demanded are to be found in the relation of the heterogeneous reagents to the colloids, and therefore in the colloidal-chemical reactions, rather than in the better understood chemical relations. One may not overlook the capital fact that other of the ripening processes are hastened by carbon dioxid, but in different degrees, suggesting the effect of a general catalytic agent. An exception, however, is to be noted in the cessation of color changes. A fruit, which is yellow when subjected to carbon dioxid, does not subsequently change to the usual deep orange of the normally ripened.

From my study of the tannin cells themselves it emerges that the increase in rigidity of the tannin-masses, a slow process under ordinary conditions, is hastened under normal, and still more under supranormal pressures of carbon dioxid, but is *preceded,* by a relatively brief period, *by the completion of non-astringency.* From this it may, for the present, be inferred that the disappearance of soluble tannin is connected with the coagulation of the associated colloid, and that the rôle of the acid, carbon dioxid, is, directly or indirectly, the cause of this coagulation which proceeds up to some, at present, unknown limit at a rate related to the amount of acid available. That, by coagulation, the physico-chemical condition of the colloid, and its consequent behavior toward tannin, may be changed finds an analogy, perhaps not too loose for my purpose, in the behavior of the micropylar colloid stopping the micropyle in the egg of *Fundulus.* According to the view of Jacques Loeb (1911) this colloid becomes "tanned" in the course of one or two days if in the surrounding water certain salts are present, thereby rendering the micropylar plug semi-permeable to sodium chloride, and so preventing the toxic effect of this salt upon the embryo within.

But whatever the importance of the explanation of the phenomena in the moribund fruit, the physiological meaning of the associated colloid during its period of development is certainly not of less. It is known that the coagulation of casein by HCl may be prevented by the association, with the casein, of another, a "protective," colloid (Alexander, 1910). On the strength of this fact, Alexander has been able to throw an important light on the digestibility of human, as compared with bovine and certain other milks. It seems not improbable that, in the growing cell, such is the relation of its associated colloid to the tannin, thus preventing its attack upon the protoplasm. This, as a working theory, has a not inconsiderable tentative value. In harmony therewith is the fact that the tannin in the persimmon, as in the date, always remains within the cell, the tannin-idioplast, in which it originates (Lloyd, 1910, 1911).

Concerning the action of heat, which, it has already been said, causes coagulation of the associated colloid, Vinson, cited above, has shown that too high temperatures, sufficient to destroy enzymes, prevent normal ripening (that is, as related to astringency), while suitable temperatures, yet fatal to protoplasm, hasten it. He sees in these facts evidence of the presence of enzymes. I have shown that high temperatures (that of the boiling of concentrated cane-sugar solution) actually coagulate the associated colloid (1911), but without the complete imprisonment within it of the tannin. It seems clear from this that the time

relation is an important one, and that, during normal ripening, an enzymatic agent is at work effecting the coagulation. If this be true, the rôle of carbon dioxid may be less direct than above indicated, and that its business lies in hastening the secretion or the activity of the responsible enzyme.

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FUNDULUS AND FRESH WATER

In a series of papers[1] published in 1906 and 1907, I presented the results of experiments in which fishes of a number of species (particularly *Fundulus heteroclitus*) had been subjected to various modifications of the salt content of the containing water and to various other abnormal conditions. Contrary to the previously published statements of Loeb[2] and of Garrey,[3] I found that in the great majority

[1] *Biological Bulletin*, May, 1906; Bulletin of the Bureau of Fisheries for 1905 (May, 1906); *American Journal of Physiology*, June, 1907. Further data were reported in a paper before the seventh International Zoological Congress in 1907 (to be published).

[2] *American Journal of Physiology*, Vol. 3, 1900, pp. 327–338. I regret to say that my criticism of this writer was framed in language which, though not intended offensively, I now recognize to have been in poor taste.

[3] *Biological Bulletin*, Vol. VIII., 1905, pp. 257–270.

of cases *Fundulus heteroclitus* died, either in distilled water or in ordinary fresh water, drawn from the water supply of New York or of Woods Hole. In my own experiments with healthy adult fishes, placed in ordinary "tap" water, death commonly occurred after an interval of from one day to two weeks, although individuals frequently lived for a considerably longer period, sometimes as long as they were kept under observation. In some of the experiments the earliest deaths occurred too soon to make it possible to attribute them to bacterial or fungous disease, while in the great majority of fishes there was no visible evidence of such disease to the last.

I have been very careful to avoid making the claim that *Fundulus* of this species could not, *under any circumstances,* live for an indefinite period, either in fresh or distilled water. Indeed, as regards the former, I cited trustworthy reports of cases in which this fish had become landlocked in ponds, etc., probably through a slow process of acclimatization. I have, however, laid emphasis upon the fact that adult specimens *do commonly* die within a few days after transfer to water entirely devoid of their accustomed salts. From recent conversations with Professor Loeb, I am led to understand that this has likewise been his own experience.[4] Indeed, in a paper[5] published during the present year he distinctly affirms that only five per cent. of his grown individuals show sufficient powers of resistance ("diese grosse Widerstandsfähigheit") to live for five weeks in distilled water. On this point, then, the difference between us seems to be merely a matter of emphasis. Loeb, for his purposes, has laid stress upon those cases in which the fishes have survived; I have laid stress upon the fact that, except for brief periods, they commonly do not survive.

In itself, it would seem to be a matter of small scientific importance whether or not any given species of fish can be transferred with impunity from one medium to another. We all know that some fishes can, while many can not, endure such a transfer. But since the experiments, both of Loeb and myself, in this field, have dealt very largely with the question whether or not this particular species would survive various experimental conditions which have been employed by us, it is of considerable importance to recognize its *ordinary* behavior in fresh water.

In a recent article[6] already referred to, Loeb has made much of the fact that I admittedly used commercial distilled water in my experiments, and would clearly have his readers believe that the death of the fishes in these experiments was due to impurities in the water. It seems hardly necessary for me to state that my use of water of this sort was deliberate and was done with a full knowledge of the fact that ordinary distilled water has been found harmful to some organisms. I used this sort of water for the simple reason that I was not, at the time, in a position to obtain sufficient quantities of chemically pure distilled water. I believe, however, that the validity of my results was not affected by the character of the distilled water employed, and this I hold for several reasons: (1) These fishes likewise died in ordinary "tap" water, in which true fresh water species lived perfectly well. Loeb's suggestion that disease germs may have caused the deaths in such cases is negatived by the fact that death oftentimes occurred within less than a day. (2) The baneful effects both of the distilled water and of the tap-water were abolished by the introduction of a very small percentage either of sea-water or of pure NaCl, as will be pointed out below.[7] (3) I must repeat Loeb's own ad-

[4] If I am mistaken in this, I trust that Professor Loeb will set me right.

[5] *Archiv für Entwicklungsmechanik,* Bd. 31, 1911, pp. 654–657.

[6] *Archiv für Entwicklungsmechanik* (*loc. cit.*).

[7] Here an appeal may be made to the antagonistic effect (discussed below) of the salts of sea-water upon various poisons, it being assumed that the distilled water had been contaminated by some metallic poison. Such an assumption could not be made, however, in the case of the tap water used, while the action of the NaCl in the two cases seems to have been identical.

mission, contained in the same paper in which he criticizes me, that all but five per cent. of the adult *Fundulus* died in his "double distilled" water. Why, then, assume that the water employed by me contained poisonous impurities? (4) Weighty evidence upon this same question is already afforded by an experiment which I have only recently commenced. At the date of writing this paragraph (Dec. 12), I have kept in distilled water for seven days eighteen specimens of *Fundulus heteroclitus,* taken from a fresh water stream and consequently habituated to the latter medium. The distilled water was prepared in an ordinary metal still. The fishes nevertheless all appear to be in perfect health, and no deaths have occurred in the lot since the first day, when two fishes died from causes having no bearing upon the present problem. This result is significant in comparison with that which had been obtained when salt-water specimens were used. The final outcome will be reported upon later.

As bearing on the question of the "protective" action of various salts, it may be relevant for me to point out that in 1906 I described experiments demonstrating the remarkable efficacy of even small percentages of sea-water in counteracting the fatal effects of fresh water upon *Fundulus.* I later showed[8] that this proportion need not exceed one part of sea-water to a hundred of ordinary fresh water. Experiments in which pure NaCl was employed, dissolved both in distilled water and in fresh ("tap") water, showed that this salt, in concentrations of 3 to 15 grams per liter (in some cases three tenths gram per liter), may preserve the lives of the fishes for three or four weeks or longer. Fishes kept in pure tap water, under otherwise similar conditions, all died within comparatively few days.

The fact that this fish will *endure* pure NaCl, in "very weak solutions," is now fully admitted by Loeb himself,[9] but he still appears to overlook the fact that, in such low concentrations, the salt in question is far from being a poison, but frequently preserves the fish from destruction.

Furthermore, we surely can not regard 15 grams per liter (a concentration tolerated by many of my fishes) as a "very weak solution." Indeed, it is roughly an $M/4$ solution, or one of more than half the concentration in which this salt occurs in sea-water.[10] Experiments in which sodium chloride was used in about the same concentration as in sea-water resulted in the death of all the (30) fishes used in from two to fifteen days.

In summing up this part of the discussion, I can but repeat my earlier statement that "In addition to such a toxic effect, however, the sodium chloride certainly has a potent *anti*-toxic effect, since, even in solutions which proved fatal, the rate of death was usually much lower than in pure fresh water. *In the aggregate, these experiments may be held to prove, therefore, that pure sodium chloride, in certain proportions, has nearly (if not quite) the same efficacy in counteracting the fatal influence of fresh water upon Fundulus heteroclitus as does the combination of salts contained in sea-water.* My previous experiments have abundantly proved, I think, that the action of this salt is not an osmotic but a chemical one" (1907, p. 73).

In a section of considerable length, entitled "The Toxicity of Certain Poisons as Affected by the Salinity and Osmotic Pressure of the Medium," I pointed out, among other things, that certain metallic salts (*e. g.,* copper chloride and sulphate, and mercuric chloride)

[8] *American Journal of Physiology* (*loc. cit.,* particularly pp. 68, 72, 73).

[9] *Archiv für Entwicklungsmechanik* (*loc. cit.*); also SCIENCE, November 17, 1911.

[10] Referring to some of his experiments with young *Fundulus,* Loeb tells us (SCIENCE, *loc. cit.*): "I succeeded in showing that as long as the sodium-chloride solution is very dilute and does not exceed the concentration of $M/8$, the addition of KCl and $CaCl_2$ is not required. Only when the solution of NaCl has a concentration above $M/8$ does it become harmful and does it require the addition of KCl and $CaCl_2$." The difference between Loeb's results and my own—of which last Loeb does not seem to be aware—may be due to the difference in the age of the fishes employed.

were more toxic in fresh water than in certain strengths of salt water, and this *even to fresh-water fishes*. One obvious interpretation is that these poisons were merely neutralized chemically by the ingredients of the sea-water, outside of the body of the fish, but this explanation is rendered improbable by a variety of considerations which can not be discussed within the limits of the present article.

The employment of pure NaCl, instead of sea-water, in these last experiments, would not probably have affected the outcome, if we may judge by recent work of Loeb, in which he found that the poisonous effect of zinc sulphate upon *Fundulus* eggs was neutralized by the former salt.

Loeb's assertion that "salts alone have such antagonistic effects" certainly does not apply to adult fishes. I need only call attention to the fact that cane-sugar solutions of certain strengths were found by me to very clearly defer the fatal action of the copper salts, both upon *Fundulus heteroclitus* and upon certain fresh-water species. It had first been ascertained that cane sugar did not, in any concentration, take the place of sea salts or of sodium chloride in prolonging indefinitely the life of *Fundulus*. Whether or not these facts can be brought into harmony with Loeb's "tanning" hypothesis, I do not pretend to know.

And now, while I am unearthing some of these long-buried records of the past, I can not refrain from repeating one of my articles of faith therein expressed:

> The writer is not in the least in sympathy with the tendency, so often manifested, to explain the most complex of natural phenomena by a few simple chemical or physical formulæ. If the principles which I have invoked [referring to certain tentative hypotheses] operate at all in the way in which I have supposed, they operate in conjunction with other principles so obscure and complex that a complete solution of these problems is certainly very far distant.

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U. S. BUREAU OF FISHERIES,
WASHINGTON, D. C.,
November 28, 1911

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

THE 74th regular meeting of the society was held at the Cosmos Club, Tuesday, October 10, 1911, at eight o'clock P.M. In the absence of the regular officers, Dr. Albert Mann presided. Twenty-five members were present.

The following papers were read:

The Wilting Coefficient for Different Plants and its Indirect Determination: Dr. L. J. BRIGGS and Dr. H. L. SHANTZ. (Presented by Dr. Shantz.)

The Forest of Arden, a Dream: H. C. SKEELS.

The Forest of Arden is a 300-acre tract of native woodland, three miles east of Joliet, Ill., in the valley of Hickory Creek, and forms a part of the 2,000-acre estate, Harlow-Arden, of Mr. H. N. Higinbotham, of Chicago. The creek is dammed in three places, with locks through the two upper dams, giving a mile and a half of boating. Five miles of gravel drives have been laid out, the purpose being to display the landscape beauties of mixed meadows and woods to the best advantage. Along these drives, beginning with the ferns and following the accepted sequence of plant families to the composites, there has been planted a botanic garden of 2,000 species, room being left for as many more.

Each species is located by its place in the sequence, and by a map, cross-sectioned to square 100 feet on each side, accompanied by an index giving the plant names and the number of the square on which each will be found. There are no formal beds and no labels, but the species are there, to be seen by those interested.

The eleventh annual business meeting of the society was held on Tuesday, October 24, 1911. Officers were elected as follows: *President*, W. A. Orton; *Vice-president*, A. S. Hitchcock; *Recording Secretary*, Edw. C. Johnson; *Corresponding Secretary*, W. W. Stockberger; *Treasurer*, F. L. Lewton. The executive committee reported an active membership of 104, there having been nineteen accessions during the year.

The 75th regular meeting of the society, held November 14, 1911, in conjunction with the Washington Academy of Sciences, was devoted to a lecture by Dr. W. L. Johannsen, of Copenhagen. The subject of the lecture was "Heterozygosis in Pure Lines of Beans and Barley."

The 76th regular meeting was held at the Cos-

mos Club, Tuesday, December 5, 1911, at eight o'clock. President W. A. Orton presided. Thirty-three members were present.

The following papers were read: :

Thrips as Pollinators of Beets: HARRY B. SHAW.

Thrips tabaci were observed to be numerous on seed beets in Utah. They were always abundant on flowering racemes, as many as 190 being collected from one small branched raceme. They were not observed to interfere with seed production. On the contrary, it appeared more probable that they acted as agents of pollination. An examination showed them to bear numerous pollen grains scattered about their bodies, as many as 140 beet pollen grains being counted on one adult thrips. An experiment, started August 7 and 8, 1911, under carefully arranged isolation conditions on emasculated beet flowers, resulted in 17.2 per cent. of the flowers to which thrips had been introduced being fertilized and producing seed. All the controls remained sterile. The conclusions are that thrips are probably important beet pollinators; that they may act similarly with other plants; that their absence or too small number may account for the non-fertilization of flowers in some localities and seasons; that they may fertilize flowers under supposedly isolated conditions and may even cross plants not regarded as capable of being crossed by insects, *e. g.*, barley; and that they may also spread fungus spores and bacteria.

Forest Types: RAPHAEL ZON.

A study of Idaho forest types revealed three main factors: (1) yellow pine-Douglas fir, (2) cedar-hemlock, both climax types, and (3) pine-larch, a transitory type. The first formation is both a pioneer and climax type; the second is a climax type preceded by the transition type, the order of succession being first the larch (*Larix occidentalis*), then the white pine (*Pinus monticola*), and lastly the cedar (*Thuja plicata*), hemlock (*Tsuga heterophylla*), and white fir (*Abies concolor*).

Phytochemical Studies on Cyanogen: Dr. C. L. ALSBERG and O. F. BLACK (by invitation).

W. W. STOCKBERGER,
Corresponding Secretary

THE TORREY BOTANICAL CLUB

THE meeting of October 10, 1911, was held at the American Museum of Natural History at 8:15 P.M., President Rusby presiding. Forty persons were present.

The minutes of the meetings of May 8 and May 31 were read and approved. Professor R. A. Harper, Columbia University; Dr. C. W. Ballard, 115 W. 68th Street; F. D. Fromme, Columbia University; A. B. Stout, New York Botanical Garden, and Miss C. Rabinowitz, New York City, were then proposed for membership.

The report of the secretary on the method of changing the day of a regular meeting was accepted. Dr. E. B. Southwick, chairman of the field committee, reported progress. A similar report was offered by Dr. Rusby, acting for the committee to revise the constitution.

Professor R. A. Harper, Dr. C. W. Ballard, F. D. Fromme, A. B. Stout and Miss C. Rabinowitz were elected to membership.

The scientific program consisted of a lecture on "Some Edible and Poisonous Mushrooms," by Dr. W. A. Murrill. The lecture was illustrated with lantern slides which had been made from photographs of specimens recently collected in the vicinity of New York City and colored while the specimens were in a fresh condition, thus enabling the artists to reproduce the natural coloration of the specimens photographed. The speaker stated that the exceptionally large number of recent deaths due to poisonous species of mushrooms was no doubt attributable to the abundant crops of *Amanita phalloides* and *Amanita muscaria* which have followed the copious rainfall of this season. Slides showing the poisonous species in several stages of growth were exhibited and the special marks of identification were pointed out. Following these were shown slides of some of the edible mushrooms easily confused with the poisonous varieties. The two most characteristic features of the poisonous mushroom are the "death cup" or volvas and the "ring" or annulus. The careless mushroom hunter may pull up a specimen, leaving the volva still buried in the earth, or the annulus, which is a more or less fragile structure, may have already disappeared, and serious consequences result from the oversight.

Dr. Murrill wished to emphasize the fact that there were no rules or tests that could be applied with certainty. It is necessary that one gathering mushrooms for eating purposes should confine his operations to such species as he knows intimately in all their various forms.

The lecture was discussed by Dr. H. H. Rusby, Dr. Thomas, E. B. Southwick and E. C. Edwards.

B. O. DODGE,
Secretary